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Forthcoming Event.

SEPTEMBER 27—OCTOBER 1.
International Foundrymen's Congress and Exhibition at Detroit, U.S.A.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

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Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.

Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

A Matter for Congratulation.

Many people in the industry outside the ranks of members will be interested in the arrangements made for the future of the Cast Iron Research Association. We reported a short time ago the highly satisfactory nature of the Report issued by the Government Inspectors. It was confidently hoped that, following this, Governmental support could be secured for an additional five years. It has been the universal experience with these research organisations that the five years for which Government assistance was originally guaranteed was insufficient to establish them on an enduring basis. Furthermore, the rosy optimism of 1919 did not foresee the magnitude of the trade slump that has intervened, rendering extremely precarious the existence of every institution depending directly or indirectly upon industry. The peculiar conditions of the founding industry, which have been previously commented on here, notably its lack of organisation, provided in the present case an additional handicap. There was therefore every reason to hope that further assistance on the scale found suitable for other industries would be increased rather than diminished for ironfounding, if the Government were satisfied with the Report of their Inspectors. Events have not falsified this expectation.

We are glad to be able to state that negotiations have now been completed, and we think that the industry should extend to the Council its very cordial congratulations on their successful outcome. The Advisory Council of the Department of Scientific and Industrial Research has agreed to provide grants for a further five years, at the rate of £1 for each £1 received in regular subscriptions for the next three years, and at the rate of 10s. for each £1 of subscriptions for the remaining two years. Naturally these terms are subject to certain conditions, the chief of which is that the subscription income from members shall be not less than £4,000 per annum. Hitherto the agreed minimum has been £2,500. That the Council should feel able to give the necessary undertaking to raise £4,000 per annum indicates the strength of the Association and the progress that has been made. With such a subscription income its total income will obviously be £8,000 per annum. The Government, however, is prepared to pay the grant up to a limit of £6,000 per annum, so that if the industry could raise this figure the Association's income would be £12,000 per annum, a sum which would for the first time be commensurate with the size and importance of the industry.

It is obviously to the benefit of members that this larger sum should be available, and we trust that makers of pig-iron, grey and chilled castings of all kinds, and malleable iron will not be slow to support this national work which is at the same time a sound business proposition, and one, moreover, that is of vital interest and importance to themselves. We venture to prophesy that in ten years' time the industry will find it cause for remark that there could ever have been any question as to the place and function of the Association.

Fortified by the new agreement, we understand that the Council has, as one of several contemplated developments, recently arranged to combine under one roof its headquarters, offices and laboratories in Birmingham. Appropriate premises have been secured within a short distance of the present offices, which will permit of much needed expansion for laboratory work, with the offices and library under the same roof. Further details will be available later.

XUM

Institute of British Foundrymen.

LANCASHIRE BRANCH WORKS VISIT.

The first works visit of the session was made to the foundries and works of Messrs. Hartley & Sugden, Limited, of Halifax. About 40 members were welcomed by Mr. Parker the foundry manager. The castings made are of a specialised character, being used solely in the production of cast iron boilers, central heating appliances, and radiators.

There are two foundries, one of which is devoted entirely to light sections, which are all polished and plated in the adjoining shop. A small but efficient mechanically charged cupola provides the metal in this shop where most of the moulding is plate moulding. Efficiently designed boxes have eliminated the use of gaggers entirely.

The larger foundry is devoted to heavy sections of boilers. The moulding here is accomplished on machines of three types. The demonstration of the roll-over jar ram pattern drawing machines illustrated the rapid advance which is being made to mechanicalise foundry operations wherever possible. Oil-sand cores of exceptional accuracy are made in large numbers in metal core boxes. The drying arrangements are very efficient, three stoves being operated from one fire; in such a way that very little heat is wasted. Melting is done in two 46-in. furnaces arranged centrally on one side of the shop.

All castings are subjected to rigid tests before assembly in the erecting shop. Steel boilers of a variety of types are made by the older process of riveting, and also by welding by both the electric and acetylene methods.

After tea Mr. S. G. Smith, the president of the Lancashire Branch, proposed a vote of thanks to the Directorate and to Mr. Parker and his staff: this was seconded by Mr. Primrose and supported by Mr. Miles. Mr. Parker, replying, said that they were pleased to have had the members of the Lancashire Branch with them that afternoon and extended a further welcome to those members who had been unable to be present on account of the difficulties of travelling consequent on the industrial situation.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Pearlitic Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Your issue of July 8 contains a letter from Mr. E. Adamson, of Sheffield, which is presumably a criticism of Perlit iron. His indictment is based on three claims purporting to have been made for Perlit iron, and while darkly hinting at other shafts in his armoury, he mercifully restricts his thunder to three peals only.

"It is a fact," he says, "that transverse and tensile tests are obtained with and without the pearlitic structure equal or even superior to those by the Perlit process." This may be so. The Perlit process makes no claim to be the sole process by which high-tensile irons can be produced. Mr. Adamson conveniently overlooks Mr. Smeeton's statement that Perlit iron has a higher impact strength than any other cast iron which he has examined; he ignores the fact that Perlit castings possess uniform properties at all points, and that the growth of Perlit iron under extreme heat conditions is almost negligible. It is because of such properties that Messrs. Burmeister & Wain, of Copenhagen, use Perlit iron in their Diesel engines, and the Perlit iron castings are included in the Werkspoor Diesel engine, as made by the North-Eastern Marine Engineering Company, and that repeat orders are being placed with those foundries which are licensed to make such castings.

Mr. Adamson continues:—"*Claims are stated to have been made* on behalf of the Perlit Company that this close-grain size obtained by the Perlit process would apply to cast-iron propellers." Surely criticism based on hearsay evidence of this kind is particularly valueless, even though Mr. Adamson later on states that his letter "is confined to facts known to the writer personally." It was never claimed for the Perlit iron process that it is a heaven-sent solution of all the foundryman's difficulties, or that it could accomplish the impossible, and no Perlit licensee in his senses would claim that he could make a large cast-iron propeller of which the boss has exactly the same grain size as any part of a blade. But he makes a sounder job with the process than without it.

Mr. Adamson's third and last point seems to be a rather involved attempt to show that Perlit cast iron can be made without the use of the published diagrams, which he claims are purely empirical. The Oxford Dictionary defines empiricism as "knowledge resting solely on experience." Again we find ourselves in entire agreement with Mr. Adamson. If he will use the diagrams intelligently in any foundry with which he may be connected he will be well on the way to the production of Perlit castings every time he makes a cast. This is our experience. We, as Mr. Adamson claims to do, merely confine our attention to facts. In ten months we have been able to recoup the sum paid for our licence, and have now turned a loss on our foundry into a steady profit.

Mr. Adamson prides himself on being only a "practical man," and pours scorn on academic discussion. Nearly all important practical developments originate in such discussion, and for that reason every practical man would do well to give due weight to the academic side of his business and allow discussion its proper place in industry.—Yours, etc.,

JENKINS BROS. (BIRKENHEAD), LIMITED.
D. T. RAIKES,
Managing Director.

Neptune Street, Birkenhead.
July 22, 1926.

Current Problems.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Arising out of your leader this week on Current Problems the following analyses of pig-iron all taken from a small 20-ton parcel recently bought may interest your readers. In our student days we used to mix in one test tube a little from every bottle in the laboratory and await results, and I am looking forward with the same keen anticipation to the mixture which results from this batch of pig when melted in the cupola. Perhaps some of your readers would hazard a guess.

	Silicon.	Sulphur.	Phos.	Man.	Carbon.
Pig No. 1	1.25	0.030	2.30	1.11	3.26
2	5.05	0.080	1.56	0.63	2.93
3	1.50	0.051	1.64	0.72	3.48
4	2.30	0.010	1.64	0.43	3,29
5	5.20	not taken.			

Yours, etc.,
H. FIELD.

John Harper & Company, Limited, Albion Works, Willenhall, Staffs, July 27, 1926.

Woodworking Machinery Regulations.

Owing to decisions recently given in the High Court, the Secretary of State proposes to revoke No. (2) of the Woodworking Machinery Regulations, 1922, and the definition of the words "within reach" in those regulations. Objections must be lodged at the Home Office, Whitehall, before August 23.

A Good Loam Mixture.—Mix together about 8 parts of Erith sand, 2 parts of sea sand, and 2 parts (good measure) of horse manure (chopped straw is a good substitute when manure is not available). Wet the whole with water. The resultant mixture is excellent for general castings.

Core-Sand Mixtures for Large Cores.—The following mixture is very satisfactory for general large cores:—Mix together new red sand (old sand gives poor results), 5 parts; sand from dry-sand moulds, 5 parts; horse manure, 2 parts, or 1 part of cow hair; wet with water. Another mixture is dried loam pounded with horse manure and mixed with equal parts of Doncaster, Snaith and Pontefract sands in water.

The Care of Patterns.

By W. Dobbs.

In most large foundries and engineering firms, where a large quantity of patterns are in constant use, every care is taken of them, both in handling in the foundry and in the pattern stores, and are kept in a high state of efficiency by this method. In some smaller foundries the general idea is, that a system of storing is a very expensive item, and it is usually left to some handyman to collect and keep the patterns and their respective parts in the best way possible, and in most cases there is more time spent in hunting round, looking up some particular pattern and its various component parts, than the value of the job may warrant. Not only so, but where no special care is taken, the patterns are usually dumped in some inconvenient place, and subjected to much rough and ready turning over, which results in damages of all descriptions, such as prints broken or knocked off, loose pieces lost or broken and core-box parts missing, etc. This involves extra time spent to replace broken or missing parts, which in these days of keen prices means a direct loss.

It is the object of the writer to describe a system that was adopted in quite a small foundry, whose work was partly of an outside-order type, and usually there were quite as many patterns in use belonging to outside customers as there were in use on the firm's own particular class of work. As there was not sufficient work to keep one man constantly employed, it was desirous to get some system that anyone could understand and keep going, without impairing its efficiency, and also to keep clear of the one-man system; by this is meant a system that is only half thought-out at its inception, and additions are made by the man storing. Thus only he knows and can work it, which causes endless trouble when the particular man is not available.

One man, who had recently overhauled a pattern stores, said he had so organised the place and installed a system that the storekeeper, who had previously handled the patterns, would have a rare job to find them as quickly as he used to, but he could lay his hand on any one he wanted. This remark favoured rather the efficiency of the individual than the system, to put it in the most charitable way.

The first step to the system used was a classification of the various classes of patterns in use, in this case letters were used for the purpose, A denoting one class and B another, and so on, and every pattern was allocated a separate number. If a classification already exists for a catalogue purpose, the same classification can be used for the patterns. The classifying by letter was found most useful in the storing, as the bays were so lettered to correspond to the class of pattern

DATE			PATTERN No.		BIN No.
DESCRIPTION				ORD. No.	
PATTERN IN		PIECES		LOOSE PIECES	
No. OF COREBOXES		IN		PIECES	
DATE RECEIVED IN STORES				DATE ISSUED	
	Description.				
A					
B					
C					
D					

FIG. 1.

	COST.				
NO.	TIME / MAT.			£ s. d.	TOTAL £ s. d.
A	T.				
	M.				
B	T.				
	M.				
C	T.				
	M.				
D	T.				
	M.				
E	T.				
	M.				
F	T.				
	M.				
G	T.				
	M.				
H	T.				
	M.				
J	T.				
	M.				
K	T.				
	M.				

FIG. 2.

stored in them. When a pattern was used for more than one type of casting the number had for the first alteration the letter A added to it, second B, and so on. Thus A116 denoted patterns as first used, A116A denoted patterns as first altered. The bays used for storing were of the usual A section, with the bins partitioned to sizes to suit the patterns to be stored in them, the larger spaces left at the bottom and the smaller at the top. The space available for this, in the case mentioned, was a small building at the rear of the pattern-shop, with windows along one side only and no roof lights, but the best lighting effects were obtained by placing the bays at right angles to the windows, thus getting the light straight down between the bays. This meant having the sections rather on the short side, as this was the narrow way of the building, but this was compensated by the good lighting effect, for if the bays had been placed longwise the back bays would have been in bad light. The sections were lettered to suit the patterns to be stored in them, thus A patterns were stored in A section, and the bins numbered consecutively from 1 to suit the number of patterns in use, with, of course, space left for additions.

The card index system was used for locating and storing the patterns, and two sets of cards were used, one in use in the stores and the other for use in the foundry office, the latter were used for reference purposes. The front side of the pattern-storing card was printed, with particulars of pattern No. Bin No. and pattern particulars—(see Fig. 1). The lower portion of the front side had spaces left for the alterations and their particulars. These spaces were continued on the reverse side in alphabetical sequence. The cards used in the foundry office were the same as Fig. 1 on the front side, but on the reverse side had particulars as shown in Fig. 2. Entries were made as to the cost, etc., and were found very useful for quotation purposes.

The cards in use were placed in the front partition in the index-cabinet drawer when the patterns were stored. When issuing a pattern from the store the card was located and particulars noted as to bin number and particulars of pattern, the pattern was then, if found to correspond to particulars given, issued to foundry and the card placed in the rear partition of the drawer. Thus all cards in the front partition of the drawer were belonging to pattern in the stores, and all cards at the rear were belonging to patterns issued from the stores.

As the cards were separated in series of 20 by the extruding tab system, it was only a matter of a moment to locate the card required and ascertain whether the pattern was in the stores or not. When a pattern was sent out other than to the foundry special particulars were attached to the card as to its destination and the card placed in the rear partition. It was found by this system that any person could find at a moment's notice where such and such a pattern was at the moment, also full particulars of the pattern and its parts. In making up the cards in respect to particulars, this was done by the man deputed to collect and store the patterns, and care was taken to see that each pattern that was made or received passed through the storeman's hands and full particulars taken and a bin number allotted.

In this system an outside customer's pattern was given a letter that was excluded from the firm's own system, this saved confusion from the firm's own letter and numbers. To make this or any system effective, care should be taken to mark all patterns and its separate and loose portions with its pattern letter and number. This he found very handy when a piece or portion of some pattern has been separated from its set, because when found its parent pattern is instantly located by the number stamped on it.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS has been registered as a company limited by guarantee, with 2,500 members. The first directors are Messrs. W. N. Haden, C. I. Haden, E. Herring, A. H. Barker, A. A. Jones, O. Stott and W. W. Nobbs. The secretary is Mr. W. G. Hollinworth, with registered offices at 38, Victoria Street, S.W.1.

Recovery of Tin from Scrap.

A belated report on "Secondary Metals in 1924," by MR. J. P. DUNLOP, and issued last February by the United States Bureau of Mines, has just reached us. The report contains some interesting figures relative to the consumption and recovery of tin in the United States.

The United States consumes more than 50 per cent. of the world's output of tin, but apparently no metallic tin was derived from domestic mines in 1924, though 11 short tons of tin concentrates were recovered from placer mines in Alaska. The secondary tin recovered increased from 30,210 tons, valued at $25,316,000, in 1923, to 31,300 tons, valued at $31,062,100, in 1924, equal to 43 per cent. of the tin imported as pig metal and smelted from foreign concentrates in the United States during the year (73,352 tons). Nearly all clean tin-plate scrap is detinned by the electrolytic alkali process, the chlorine process, or the alkali saltpetre process.

The tin reported recovered in alloys and compounds in 1924 included the tin content of products made in several plants from clean tin-plate scrap. The materials recovered included some tin crystals, tin oxide, and putty powder, but consisted mainly of tin tetrachloride and tin bichloride. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin. The largest recoveries of tin were made from the scruff and drosses that occur in making tinplate and terne plate; they amounted to about 6,100 tons. The quantity of tinplate and terneplate made in 1924 was 1,419,654 long tons, or about 88,000 tons less than in 1923.

About 3,034 short tons of tin was recovered from clean scrap tinplate, either as pig tin or as tin chloride, tin crystals, or tin oxide. Apparently only about 600 tons of pig tin were recovered from scrap tin (not tinplate) clippings, old tin pipe, tin foil, and collapsible tubes. Old block-tin pipe is most acceptable scrap, but the quantity available is small and is steadily declining. A considerable quantity of tin was also recovered from waste tin liquors used in dyeing.

Nearly all the tinplate scrap imported in 1924 came from Canada. A comparatively small quantity of old tin containers was used to make sash weights by remelting in a cupola. No tin was recovered from this process, and the impure metal recovered is not suitable for ordinary castings, being too brittle. An investigation conducted by the Bureau of Mines showed that in an electric furnace detinning the scrap was impracticable, though synthetic cast iron made from tinplate scrap was used successfully in making castings of good quality. A small part of the clean tin strips cut from sheets is sold to makers of boxes and baskets, who use it to bind, strengthen, or fasten the tops of the containers they make.

The relatively small quantity of secondary tin recovered from tinplate scrap and old tin-coated cans is significantly shown when compared with the quantity of tin used in making tinplate. It is estimated that 28,900 short tons of tin were used by makers of tinplate in 1924, and that the total recovery of tin as metal and in compounds from tinplate scrap was 3,034 short tons.

THE EDUCATION COMMITTEE of the London County Council have been recommended by their Consultative Committee on Engineering to award Robert Blair Fellowships to Mr. M. D. Bone, of St. Albans, and Mr. E. W. Fell, of Ulverston, Lancashire. These Fellowships, which are of the value of £450, and are the most important scholarships in the gift of the London County Council, are awarded to young engineers of high promise to enable them to undertake research overseas. Mr. Bone, who is a student-assistant with the Consett Iron Company, Limited, is the son of Professor W. A. Bone, of the Imperial College of Science and Technology, South Kensington. He will use his Fellowship for the study of iron and steel manufacture in Continental works, mainly in Germany. Mr. Fell is a research student in the University of Birmingham. He also proposes to undertake research in the metallurgy of steel at the Technische Hochschule, Aachen, Germany.

Pattern Plates.*

By E. Ronceray (Vice-President, French Foundrymen's Association).

(Slightly Abridged.)

Pattern plates for machine moulding constitute an extremely important problem that may be considered in several very different aspects. If foundrymen in Europe had a similar problem Americans have to solve, manufacturing as they do on a scale anything from 20 to 100 times larger than here, the European might perhaps be able to go to the expense of making all metal pattern plates obtained by expensive machining processes, but the price of which, when spread over a large number of castings would prove moderate.

Even the most important of European markets cannot be compared to the American in this respect. Not only the problem of the pattern plate in Europe entails the necessity of reducing its price to the minimum, but these same conditions must also be applied to the machines on which it is mounted.

American machines have often been made for one size of box, a definite type of casting, and very often for a single casting, whereas European manufacturers, to live and sell, are obliged to make their machines much more adaptable. These are the main reasons why Americans and Europeans have prejudice against the machines that have not been made for them. The Americans use few or no European machines, and find great difficulty in sending into Europe the machines that

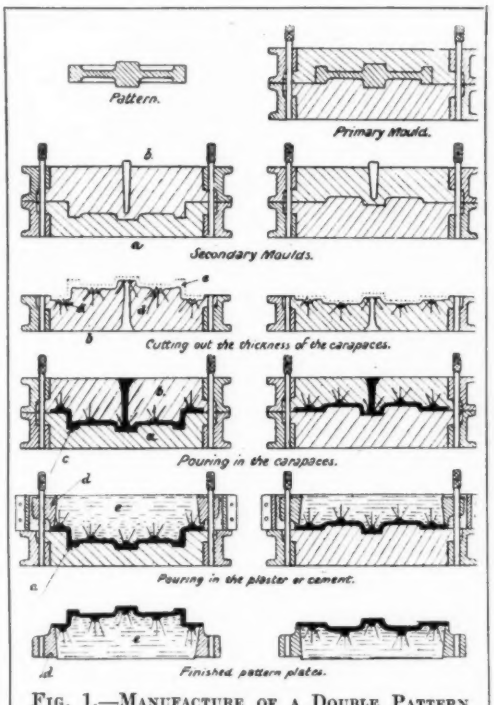


FIG. 1.—MANUFACTURE OF A DOUBLE PATTERN PLATE.

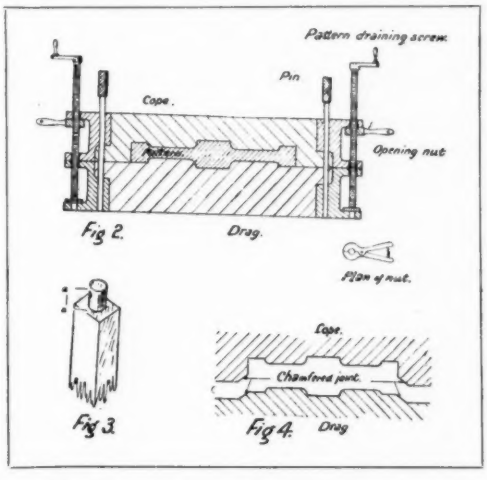
they build for their market, except in a few cases in which the above considerations are taken into account.

The builders of the first European machines were faced with the difficulty of adapting their machines to the needs of the market, and have had great difficulty in finding a wide sale, owing to the high price of pattern plates, which bore no comparison with the requirements of the available markets. Not until cheap and quick methods of manufacturing pattern plates had been discovered were machines extensively used.

The starting point was a patent, taken out in 1890, as the result of the work done by M. Saillot, at that time shop manager of the Chemins de Fer de l'Ouest, who afterwards joined the author's firm. The object of Saillot's work was to overcome the difficulties he had encountered in using German machines, which necessitated using metal pattern plates machined all over, and therefore very expensive to produce.

Pattern plates made to M. Saillot's notions were shown at the Paris Universal Exhibition in 1900. The Bonvillain Works, in collaboration with M. Saillot, not only developed these processes, but also the type of machines specially designed to get the best out of them.

The present methods of manufactuirng pattern plates and coreboxes adopted by the Etablissements Ph. Bonvillain et E. Ronceray include a



considerable number of improvements, some patented and the others not patented, and apparatus to facilitate their use.

The principle constantly in mind is to do everything in the foundry itself and dispense with the machine shop almost entirely by making the most complicated pattern plates and coreboxes by a simple moulding operation. For simple work a good moulder can learn this work in a few weeks, and thus render valuable service. For complicated work, a little longer time is necessary, and the moulder must be intelligent to enable him to combine the various points involved in the process.

When M. Saillot was first engaged on the work the means then known for saving time in moulding operations were principally the following:—

(1) Match plates, obtained by separating two parts of a box forming a mould, with a metal frame or with sand.

(2) Plaster pattern plates, obtained by casting plaster in a box of suitable form on a sand half-mould.

(3) Completely machined metal pattern plates.

The first of these processes was used mainly for hand-moulding. It is known by the name of match plate-moulding. As will be shown, it has been recently resurrected for mechanical moulding.

The second method was used either for hand or machine work, but apart from the fact that the strength of the plaster pattern plates left much to be desired, the field of application was very restricted, the slightest difficulty in pattern drawing or the smallest loose piece or fragile part becoming an insurmountable obstacle.

One of the first improvements was to coat the surface with metal by employing the "thicknessing" method used by art moulders, at the same time, permitting easy matching of the pattern-plate boxes and their accurate pattern drawing.

Practical Details.

The appliances specially created by the Etablissements Ph. Bonvillain et E. Ronceray consist of a series of boxes of suitable form, specially

C

* A Paper read before the Czecho-Slovakian Foundrymen's Association.

and carefully machined on both faces, and lined at the pin distance with carefully bored bushes set truly vertical. These bushes are generally placed inside the box, and the matching is effected by accurately ground rods passing through them. The boxes include outside flanges for reinforcement purposes, with holes drilled in them for taking the screws used for helping the process of pattern drawing. Special opening jaws threaded inside serve the function of removable nuts.

A mould is first of all made in sand, as shown in Fig. 2, using as many patterns as the pattern plate has to comprise. Very great cleanliness and care are observed in this work by using sand

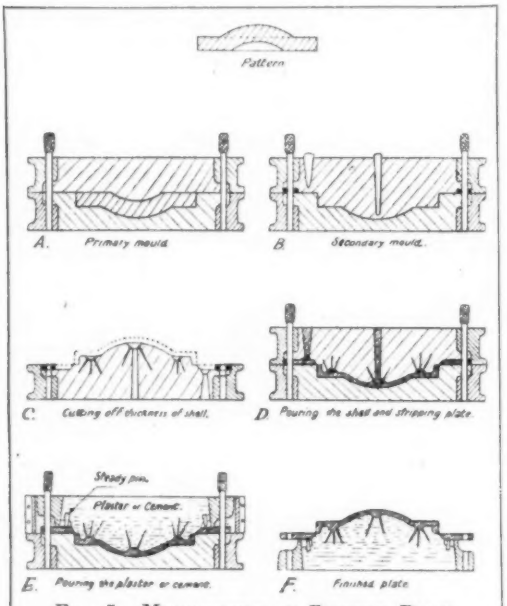


FIG. 5.—MANUFACTURE OF PATTERN PLATE WITH STRIPPING COMB.

specially prepared, quarried at Fontenay-aux-Roses.

This mould is stripped by using screws and leaving the pins in place, so as to ensure proper guiding. The pattern is lifted, the runners are cut, and one of the half-moulds is put on one side.

In the other (Fig. 1) a box (*a*) is placed and rammed, which gives the counterpart (*b*) of the half-mould, *i.e.*, it has exactly the reverse shape, projections opposite depressions, and *vice-versa*. These two half-moulds, when placed on each other, must not leave any clearance.

In the box (*b*) which has just been rammed, a certain thickness of sand (*c*) is cut away, not only on the part corresponding to the pattern, but also on the joint which is to form the thickness of the pattern plate. This work is facilitated by means of the small tool shown in Fig. 3, the part *a* of which equals the thickness *c* which it is desired to give to the shell of the pattern plate. The part that has to have the thickness cut away on it is sprinkled with talc, and by inserting the tool at various points until the heel touches the sand, the depth of thickness is shown, as the projecting part carries the talc with it, and thus leaves white marks which guide the workman in his operation of "thickness cutting." When doing this work, small bosses *d* are shaped in the sand, and at the centre of these bosses nails are driven in in various directions so as to set the shell firmly to the plaster. Runners are then cut, the moulds finished off, the part *b* that has just had the thickness depth cut away is placed on the other part *a*, and the mould thus made is poured. In this way a thin metal shell *c* is obtained, the good side of which corresponds to the mould joint and the pattern, and having at its back side nails securely fixed by their heads in bosses. Without moving it, this shell is covered by a frame *d*, adjusted to the point where the screws separate, and plaster *e* or cement is run in. The whole is now solidly set together, and, when dry, forms a strong pattern plate, the used surface of which is of metal.

For this purpose a lead-antimony mixture about the eutectic alloy is used. This is cast at a temperature close to the point of solidification, this temperature being checked by plunging a piece of paper into the liquid alloy. The colour assumed by the paper indicates the suitable pouring temperature. The second pattern plate is made under the same conditions and by an exactly similar process.

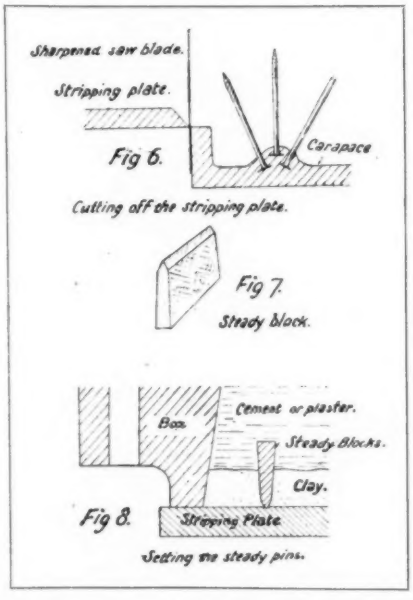
The sequence of operation is explained by the sketch in Fig. 1.

A recent improvement consists of taking the joints of the angular parts at an angle, as in Fig. 4—an arrangement that greatly facilitates pattern drawing by eliminating the weakness of the edges and soft ramming in sharp angles.

If there are any loose pieces they are first made by moulding, either from a little pattern or by shaping their form in the sand or the plaster. They are afterwards placed in the mould with a suitable parting. They are generally made of aluminium, on which the lead-antimony alloy is "shaped," thus forming dovetail joints, etc.

If the work is difficult and takes time, two plaster parts are cast on to the two first parts of the box and form the outside aspect of each of the two pattern plates. It is thereby possible to obtain further as many sand moulds as desired similar to the first two, and this facilitates certain operations. Thus it may appear difficult to lift a sand mould rammed on to another sand mould without breakage. One of these may be carefully broken, so as to arrive at the other in a similar fashion to the method applying in the operation of sweeping. There is no difficulty in this, as it is easily possible to reproduce the broken part. This is the method used for getting a simple pattern-plate.

Where the part is more complicated the operation is slightly different, and comprises the inter-



mediary operation of parts cast in plaster in accordance with improvements described in a more recent patent.

Making Stripping Plates.

Almost at the same time the economic manufacture of the stripping plate was invented. The cast iron or bronze stripping plate generally obtained by a mechanical process, was known, but was almost exclusively used for gear wheels, any difficulty in connection with the joint or the pattern drawing rendering its use practically impossible. The problem was then to make it cheaply and apply it in every case.

In the first case the stripping plates were poured separately from the shells. Shrinkage was a trouble at that time, and very quickly led to another improvement enabling the stripping plate and the shell to be made in one piece. The

sketches comprised in Fig. 5 will show the sequence of operations in a simple case.

The preliminary operations are effected exactly as before. They differ only when the operation of cutting the thickness is reached. This is then carried out as shown in Fig. 5.

It is usual to make the stripping plate a few millimetres thicker than the shell, but when working in this way the shrinkage of the shell and the stripping plate is the same, and consequently, if the cutting-off operation is done properly there is no need for fitting. The cutting off may be facilitated by leaving the delicate part of the contact between shell and stripping plate to be made last and returning the mould with talc. The result is a white line, which serves as a guide.

It will readily be understood that the stripping plate may easily be cut even if in order to strip a difficult part, it has to form part of a core-print or of the pattern.

To facilitate pouring the shell and the stripping plate are connected by small runners which are then removed by the chisel at the same time as the shell and stripping plate are parted. For this purpose a fine tool is used, *e.g.*, a small piece of a saw-blade sharpened to a fine edge (Fig. 6).

When the shell and stripping plate are separated and put into place the latter is coated with molten tallow or with oil, and the plaster or cement are run on. The carapace, having the usual nails in it, is thus sealed into the pattern plate, whereas the stripping plate, which is free, surrounds it.

A recent improvement consists in supporting the stripping plate on steady blocks and leaving between the stripping plate and the base of the pattern plate a space of 10 to 15 mm., in which the sand may accumulate. This prevents the stripping plate warping on ramming up when a little sand falls on this particular spot. Sand thus finds room to accumulate, and occasional cleaning is all that is necessary. In order to carry out this improvement strips of clay of the required thickness are placed on the rear face of the stripping plate, this clay covering all the surface that is to be reserved. The struts or steady blocks which are of the shape shown in Fig. 7, are buried in the clay, and a smart blow with the hammer forces the sharp edge of the pin into the

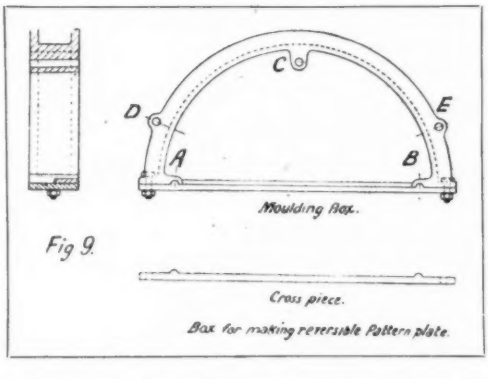


Fig 9.

stripping plate to form a bearing surface (see Fig. 8). The cement is then run in, and fills up the frame, the steady blocks and the shell. When the cement has set the job is cleaned and the clay removed, leaving a stripping plate suspended on the steady blocks.

Cutting out may be facilitated by placing rubber plates on the surface of the mould where the sand to be cut is rammed or by pieces of wood or clay used as thickeners, or finally by means of the small marking-out tool described above.

It is understood, of course, that the runners and vents to be provided in the final mould are cut out so as to obviate all subsequent retouching.

The manufacture of pattern plates by the moulding process of the reversible type, *i.e.*, pattern plates, enabling a complete mould to be made by successively ramming two parts of a box on to the same plate, dates back to about the same period. This was very successful from the start, because it is a neat and attractive one, and especially as at this particular period, when machine moulding had not progressed, it enabled the work to be done with a single machine. This method is much less used now, because it does not enable the space to be utilised so well, or the patterns to be arranged in the best way to get successful castings, and finally because better methods have been discovered. It is, however, very useful in certain cases, and is worth describing. It requires a very ingenious equipment, including, in addition to the material mentioned above, two similar moulding box parts carefully machined, and which may form a moulding box of a double surface by swinging one of them round an ideal straight line passing either through the axis of the pins or through a central line perpendicular to this axis. The line in question is one side of the half-box, the shape of which is maintained by a cross-piece placed below the joint. These two

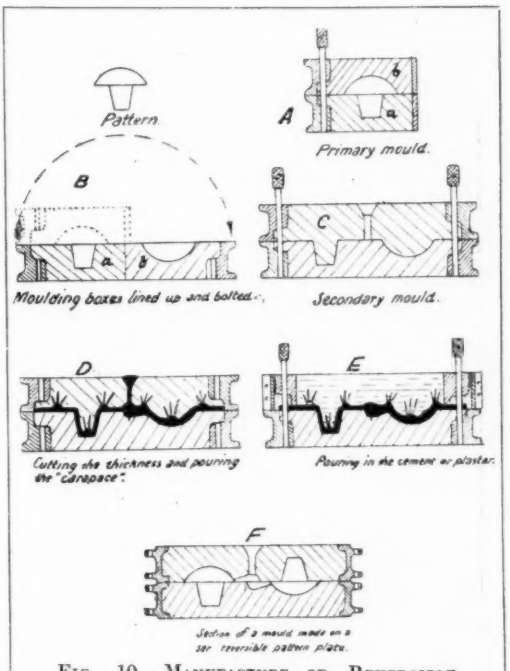


FIG. 10.—MANUFACTURE OF REVERSIBLE PATTERN PLATES.

half-boxes are generally semi-circular, and comprise two half-holes A and B cut through by the face perpendicular to the plane of the joint containing the line mentioned above, and a hole C at the apex of an isosceles triangle the hypotenuse of which is the line joining the centre of the two half-holes. Holes D and E drilled in the flanges enable the box to be raised by screws as in the double-pattern plates. An accurately surfaced plate enables the side A B to be closed as far as the joint, to enable the ramming of sand in the box.

The operation is carried out as follows:—

Using the two parts of the box described above, a mould *a*, *b* (see Fig. 10) of the pattern or patterns is carefully made and the pattern is drawn with the usual care. The plates are removed, and the semi-circular boxes are placed side by side in *a*, *b* (Fig. 10—*b*), just as if they had been opened by pivoting them about the line A, B. The boxes are made with extreme accuracy to enable the work to proceed easily and quickly without hesitation.

The boxes being bolted in this position, the only other thing to do is to materialise the counterpart of the mould by the processes described above for the double-pattern plates with or without stripping plates. The work is exactly the same, and there is no need to repeat the explanation given above.

The reason for the holes being arranged as they are is to permit of obtaining a rectangular pattern plate symetrical according to the longitudinal or transverse axis; that is to say, if the two dowels are following the longitudinal axis, to obtain the symmetry either in the direction of this axis or an axis perpendicular to its centre. This

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is necessary for certain types of castings. This is not so, however, in the case of a round box, because the space available in the half-surface is always a semi-circle.

The process described above is very convenient and rapid, and requires special equipment. This equipment is preferable when a standard dimension is being dealt with. But where special dimensions, not much used, are involved, a reversible pattern plate may be obtained perfectly without open boxes, by pouring plaster in accurate boxes in half their area. This process, invented and re-invented by numerous workers, is not worth a detailed description because of its simplicity and restricted scope. Of course, the stripping plate may be applied to the reversible pattern plate as to the double pattern plate.

The "cliché" process is a development of the reversible plate. This method consists in arranging side by side in a frame a certain number of small pattern-plates of the reversible type, which may be changed according to the nature of the orders received. It has the same advantages and drawbacks as the reversible pattern plates mentioned above.

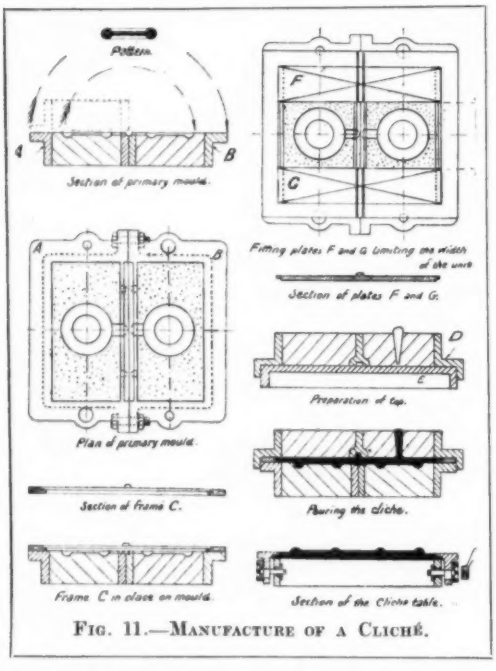

FIG. 11.—MANUFACTURE OF A CLICHÉ.

The "cliché" or unit is a small pattern plate entirely of metal, of constant width and thickness and of variable length, and containing right and left of an ideal axis situated at the plane of the joint and in the middle of the width, the half-patterns to be reproduced. The cliché (unit) is cast, partly in sand, partly on metallic surfaces machined according to the special jigs used in making it.

By placing end to end on the frame a number of clichés of appropriate length a composite pattern plate is produced having a length corresponding to the frames employed. Only a few minutes are necessary to replace one unit by another. The frame and the jigs used to make the clichés must be very accurate.

The jigs to make clichés are shown in Fig. 11. They comprise two reversible boxes A and B, similar to those described above, but entirely closed, and not having pin holes. The side corresponding to the edge about which the box is rotated is milled so as to give a radius of 90 (*i.e.*, like fourths of circles), the opposite sides are milled accurately to a given distance of this edge. Their fixing in this position is obtained through taper pins.

A frame C, having the same thickness as the clichés, *i.e.*, about 10 mm. ($\frac{3}{8}$ in.), has two cheeks corresponding to those of the small bars that fix the units on the table.

A covering box has, at its centre, a bar having milled in it a groove corresponding to the tongue forming the reference mark of the u on the table. This groove is exactly at the middle of two milled shoulders which fit exactl into the sides of the open boxes. A surface plate and a loading weight complete the outfit.

When using the two parts of the turnover box a mould is made with the pattern or patterns being dealt with, and it is opened as if to make a reversible pattern plate. These two parts of the box being bolted side by side, the frame C is placed on top, and the length of the cliché is limited by the plates F and G sliding in the frame, and by the cover box, after having rammed sand in it on the surface plate E. It only remains to pour white metal in order to get a small pattern plate corresponding to the definition of the "cliché" given above.

The double-face pattern plate has been taken up again recently by the Etablissements Ph. Bonvillain and E. Ronceray for use with new types of machines ramming the two parts of the box together. The principle is as before, but special outfit for carrying out the work quickly and accurately have been provided. Fig. 12 shows the equipment and the several operations in the manufacture of pattern plates. The white metal forming it is run into a cast-iron plate comprising numerous dovetail-shaped openings.

The information given above applies to very simple cases, the only ones it is possible to give in a paper of this kind. It would take a book to describe the advantages that an intelligent man could derive from the whole of the processes and equipments perfected by the Etablissements Bonvillain et Ronceray during the twenty-five years they have developed them. A minute description would also be troublesome and difficult to follow, and those interested are cordially invited to come and see the actual operations in the foundry of the above Company.

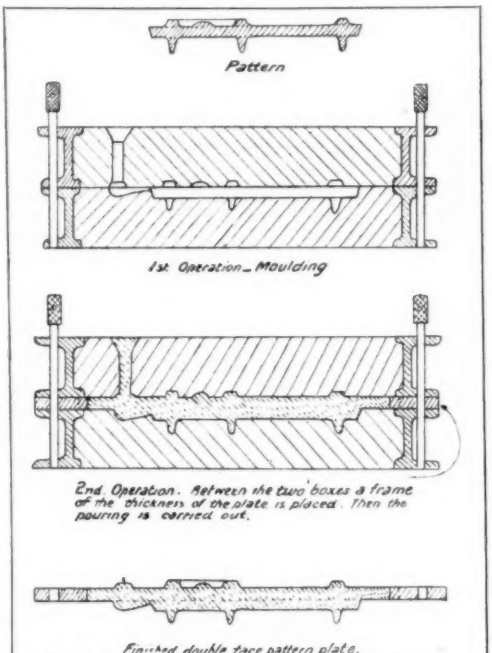
Pattern
1st. Operation.—Moulding
2nd. Operation. Between the two boxes a frame of the thickness of the plate is placed. Then the pouring is carried out.
Finished double face pattern plate.

FIG. 12.—MANUFACTURE OF A DOUBLE-FACE PATTERN PLATE.

The processes and operations used for the manufacture of pattern plates have been extended to the production of metal core-boxes. Everyone realises the difficulties encountered in working with wood core-boxes, which are inaccurate, clumsy, and subject to atmospheric changes. Core-boxes, accurate and of invariable dimensions, can be carried out in aluminium by moulding at prices approaching those for wood boxes, simply from a core made of wood, plaster or metal. The box is built up with pieces of plaster on the core, with absolute accuracy, by using simple tools, then reproduced by moulding in aluminium.

The Mechanical Testing of Cast Iron.*

By H. R. Pitt.

INTRODUCTION.

The valuation of metals and alloys by measuring their mechanical strength in different directions has occupied the minds of engineers from time immemorial, but the application of measurable forces to cast iron is comparatively modern.

The reason for this is not far to seek, for until the last ten years cast iron, although the most generally used metallic material, was not regarded as capable of manufacture within definite limits of strength, and as ample safety limits were allowed for by heavy construction it was generally considered to be out of competition with steel, bronze, brass, etc., and as most of the purposes for which it was used were of the rougher kind where excess weight was of little importance. Cheapness and simplicity of founding being the first consideration, cast iron remained for a long period a much neglected metal, almost unworthy of the attention and research of scientists and technicians who devoted their attention to wrought iron, and later to steel, copper alloys and aluminium alloys.

Now, however, a general advance in the knowledge of metals and their properties has at last involved cast iron in its purview, and technical men are beginning at last to examine its properties, to ascertain its characteristics in the light of modern research and technical practice, and one of the many results is a demand for its supply in definite qualities and mechanical properties.

The progress of metallurgical research and knowledge has further developed varieties of cast iron which greatly enlarge its application and extend its possibilities as construction material, which at the same time should enable the engineer to reduce the size and weight in his designs and give him greater confidence in cast iron as a material capable of bearing loads, withstanding shocks, enduring friction, wear and tear and the like.

Bases for Property-Determination.

The successful assessment of strength values and definite measurement of mechanical property requires the fulfilment of the following conditions:—

The provision of suitable test pieces or test bars produced in a manner that shall guarantee their being representative of the material under examination. This implies that such portions as are put under test shall be manipulated in a manner precisely similar to the castings; thus it is frequently insisted upon that test bars should be cast-on, but for obvious reasons it is more often made a condition that the test bars shall be cast from the same ladle of metal and at the same time as the casting or castings themselves.

The next essential is a machine or apparatus capable of accurately applying and measuring the stresses to which the metal is to be subjected. Further, the tests must be carried out with all due regard to the capacity of the material to meet direct or indirect loads and strains, and with careful provision that, as far as possible, the only stress applied is the one involved in the test, viz., the load indicated on the gauge or steel-yard. Without special precautions it is not easy to apply a measurable tension without at the same time bringing into play a bending strain upon the specimen.

Instances are not wanting in the author's experience where test results have been quoted with confidence, and where material has been condemned by results which on investigation were proved to be obtained under conditions which subjected the test piece to important strains other than those indicated by the measuring instruments, entirely modifying the ultimate indicated load, and which figures when the altered conditions were introduced were enhanced into quite satisfactory results.

* A Paper read before the West Riding of Yorkshire Branch of the Institute of British Foundrymen.

Basic Differences Commonly Ignored.

It is commonly required by engineers that cast iron of a certain minimum tensile stress shall be supplied, and tests are carried out by a test-room staff who, while accustomed to testing steel and ductile non-ferrous alloys, are quite inexperienced in handling cast-iron tests, and low values of seven and eight tons per sq. in. are thus certified. The most frequent cause of these low and misleading figures is the lack of adjustment in grips and holders for ensuring dead-central axial-pull; in consequence of this deficiency the tensile test-piece, probably only about 0.5 in. in diameter, is subjected to a bending strain while loaded in tension, and the fracture takes place at about half the expected load.

It will readily be seen that cast iron, a practically non-ductile unelastic metal, is very sensitive to bending strain or to torsional strain, and that any lack of direct easy adjustment attacks the metal in thin sections at its weakest point; frequently under these conditions also a shock is brought into play by the effort of the test piece to adjust a non-yielding fitment to its own direct pull, as in a case where the test piece is not truly aligned before the load is applied.

Further examples of these abortive tests are to be found in worn knife edges or test bars for transverse tests which are badly moulded so that the faces are not dead parallel, which may easily result in twisting the bar while loading it. Under these unsatisfactory conditions it is impossible to assess the strength of the iron, and the very important relation between breaking load and deflection is entirely lost.

In the tensile test a point of vital importance is the method and manner of gripping the test piece. There are in general use a number of devices for fixing the ends of the test piece into the machine, and the writer would unhesitatingly rule out any that were not freely swung or of easy movement in all directions.

Even a cup and ball joint may not be quite sufficient, for in testing small sections in cast iron, sometimes unavoidable if a test is to be taken at all, the slight friction leads to an adjusting movement or slip when the test is applied, which gives the test piece a jar with disastrous results.

Many more instances could be given proving the need for meticulous care in making tests, but it will probably be argued that tests on a supersensitive material can only be interpreted within wide limits, and that the allowance given by a generous safety factor will meet all the uncertainties of the test.

Modern Irons Require Special Care in Testing.

This, however, is not sufficient when new materials such as are now under consideration necessitate accurate and precise tests to determine their finer qualities, and to enable a proper discrimination between two or more irons, each of which can show a tensile strength in the region of 20 tons, and to come to as definite conclusion as possible by comparison of their test values.

It is thus when it comes to competition between Perlit, Emmel Thyssen and similar irons that a special care and skill is called into requisition in handling of tests, and here it is that the need for new and more precise testing apparatus and appliances appears.

In these materials claims are made that, beyond the tensile strength and high bending stresses with abnormal deflection they exhibit, they have high shock and fatigue resistance. Indeed, it is represented with considerable justification that the possession of high strength under static conditions is not the highest quality of metal, and that the very property that fits it to perform a higher function renders it liable to auxiliary stresses which it must also be proved to withstand before it comes into service.

Testing Requirements now Altered.

This and other considerations have brought into the testing of high-duty cast irons the factors formerly applied only to steel and certain non-ferrous alloys. Twenty years ago a simple transverse test, such as the breaking of 1-in. square bar on a span of 12 in., was thought to indicate all that was desired, and even the degree of deflection was not always noted; occasional tensile tests were taken under very doubtful conditions, and all requirements seemed to be satisfied by a breaking load of 9 tons per sq. in. The position is vastly different to-day.

Impact values, hardness, measurements, extension, drill tests and other tests are frequently

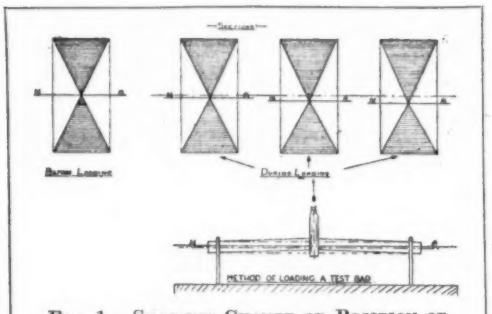

FIG. 1.—SHOWING CHANGE OF POSITION OF NEUTRAL AXIS IN A 2-IN. × 1-IN. C.I. TEST BAR.

applied to cast iron, and the study of fatigue in cast iron has brought into prominence the repeated impact test, whereby the metal is subjected to a succession of blows in more than one direction, the number of blows it withstands before fracture being automatically indicated and constituting a measurement of its fatigue limit.

The usefulness of such a test is perfectly obvious when the material forms a moving part in an engine or machine, such, for instance, as a piston, a piston-ring, a fly-wheel, cog-wheel, or where it while stationary takes impact or withstands altering pressures as in a cylinder or liner.

The first stage in impact or shock tests is seen in drop testing, and variety of such tests have been in vogue on workshop lines sufficient to measure within limits the capacity of cast iron in various forms to withstand a number of blows or the fall of a weight from various heights. While this type of test furnishes very useful means of test comparisons, it does not form a standard valuation whereby a certain material may be definitely compared with others or given varieties of the same class of materials accurately related.

Impact Testing.

Through other stages the registering impact machine was finally evolved, and the Izod is the best-known type of these. The impact machine, like other testing devices, was the outcome of the necessity for obtaining definite means of determining the qualities of steel, and of assessing and comparing the values of steel of special and alloy varieties, and especially of these metals under different phases of heat treatment.

It will therefore be obvious that its application to cast iron is limited, and the impact machine as arranged for steel testing is not of much service; the usual specimen under test is only $\frac{1}{16} \times \frac{3}{8} \times 2$ in. in dimension and having a V notch, and such small sections of cast iron are, of course, quite out of the question; larger sections may, however, be used, and within limitations give information of some value, though investigations are still proceeding to ascertain how best this type of test can be applied to cast iron. In view of the great advance in property and strength of recently evolved special irons, this type of test will undoubtedly become of great value.

Impact testing is divided into two classes: direct single impact as carried out by the Izod machine, and repeated impact as by the Stanton, Eden Foster, and latterly the Krupp machine made by Mohr & Federhaff, of Mannheim.

The deflection of a bar of cast iron under transverse test might be thought to give a good index of the behaviour of the metal under suddenly applied stresses, but no reliance can be placed upon this factor for the reason that one is dealing with a metal structurally crystalline and also non-homogeneous, and the strength of such a metal depends largely, if not entirely, upon the condition of its intercrystalline constituent or constituents as well as upon the strength of its individual crystals and the cohesion existing between them.

Influence of Graphite and Crystalline Structure on Results.

The more definitely crystalline a body is the more susceptible is it to disturbance of applied force, and unless its crystals possess the property of ductility to a marked degree the disturbance of the crystals means the fracture or disruption of the mass.

Beyond this, there is in cast iron the graphite which, while under certain conditions combining with the iron to form a strong and hard carbide, is also easily capable of deposition when it forms a separating layer between the metallic grains, thus greatly reducing the coherence of the metal; further, graphite is a weak, soft, light body, an excellent lubricant, and one which at low temperature is supremely indifferent to iron, and though present in iron is not of it, but simply

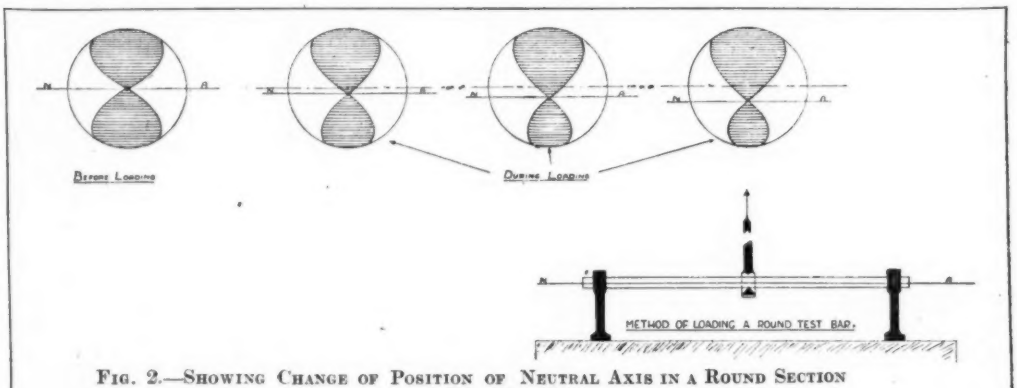

FIG. 2.—SHOWING CHANGE OF POSITION OF NEUTRAL AXIS IN A ROUND SECTION C.I. TEST BAR.

acts as an interrupter of structure and a weakening agent. It is true that many highly graphitic irons are soft and non-malleable, but that is because the iron is practically uncombined with any carbon and thus in its softest state. One would not, however, recommend these irons as being capable of resisting blows; indeed, one finds these irons weak in all directions.

Now the shock-resisting quality of iron is dependent upon its internal structure and the character and arrangement of its constituents, a consideration of which is outside the scope of this Paper, but the measurement of its properties is manifestly incomplete without determining the degree of its resistance to disturbing forces, alternate stresses, directional impact and forces of that order.

Shock-Resisting Values.

The knowledge that the tensile strength of a certain cast iron is 12 tons to the sq. in. and that its transverse strength on a bar 1 in. square is, say, 28 cwts., gives an impression to the user that it will for any length of time resist stresses within these limits, but it is well known that much lower stresses, if continually or frequently applied, have a weakening effect, and, further, that any stresses constantly or variously brought to bear upon a metal reduce its capacity to withstand higher loads and proportionately weaken it.

Such effects are called fatigue effects, and they now form an important branch of investigation in assessing the qualities of cast iron. The structure of cast iron being essentially granular as distinct from fibrous, it will be readily seen that it is peculiarly susceptible to disturbance under shock, the result being a loss of cohesion and a weakening resulting from the loosening of the structure.

This weakening is broadly proportional to the size of grain, and incidentally to the degree of interruption of the structure by interposition of graphite flakes in the mass, which have a very marked effect upon the grain, size and cohering quality of the metal, and make it readily understood why fine-grained iron with small and evenly

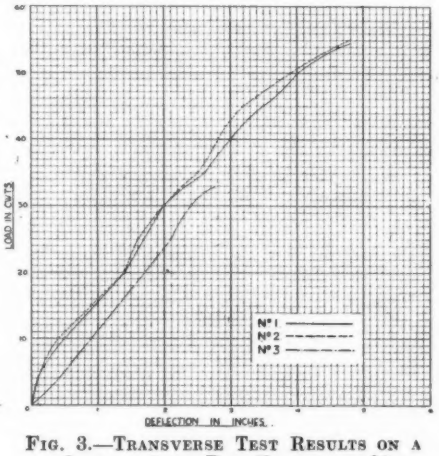

FIG. 3.—TRANSVERSE TEST RESULTS ON A 2-IN. × 1-IN. BAR TESTED ON 36-IN. CENTRES.

distributed graphite is so superior in strength and quality to the open and coarse-grained varieties.

It becomes therefore very necessary in assessing the quality of high-duty iron to apply tests which will measure its endurance under intermittent loads under dynamic rather than static conditions, as it may well be that an iron giving a very high tensile-stress will, on account of brittleness and extreme hardness or structural inequalities, break down under low loads when subjected to such stresses under moving conditions, as, for instance, vibratory stresses, shocks or impact when stressed well within the limits of fracture.

The effect of loading upon a metal section is to bring into play in that section certain lines of force or to disturb the internal structure of the material. If the material be capable of distortion, either temporarily, or of permanent distortion without fracture, it possesses elasticity or fluidity, the property of flowing, and the tenacity of a metal is largely governed by its properties in this direction.

In the case of cast iron, particularly the older and more definitely granular varieties, the section will break down before any observable distortion takes place. In a mild steel the section first undergoes temporary distortion, which at a point in the loading reaches its maximum, and this point marks the elastic limit; beyond that point any increase of the load produces permanent distortion and the elongation in a tensile stress is started, while if the strain applied is a transverse one, bending results.

Determining Factors.

The structure of the metal is the important factor in determining the degree of distortion, either temporary or permanent, before fracture under load applied in any direction, and the fact that deflection, permanent bend or elongation are only existent to the minimum extent in cast iron is explained by its granular structure, the size of the grains, and the fact that its constituent crystals are prevented from definite coherence by flakes, plates or other form of graphite disseminated throughout its mass.

In applying measurable mechanical stresses to such a material these properties and qualities must be duly considered in selecting the tests to be used, and also in the manner of applying them, as, for instance, the rate of application of loads in a transverse test.

It will be of interest at this point briefly to study the stress diagrams of sections such as are commonly used in tests of cast iron (Figs. 1 to 4).

Standardisation Required.

In order to render test results readily understood a degree of standardisation is required, so that the figures quoted shall convey a definite value without the need of translation or conversion. In this connection it is regrettable that a universal standard of measurement has not been adopted, as British methods of expression, such as tons per sq. in. and loads in cwts. and lbs. are

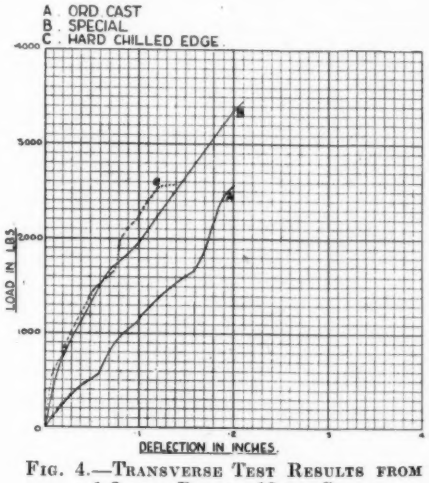

FIG. 4.—TRANSVERSE TEST RESULTS FROM A 1.2 DIA. BAR ON 18-IN. SPAN.

not readily comparable with Continental terms in Kg. per sq. cm., etc.

Further, the sizes of sections subjected to test should be stated, as, strictly, the only comparable tests are those conducted on similar sections on the same type of testing machine, and accepted factors for co-relating tests on various sections as calculated from engineering formulæ are now accepted as being subject to departure in a considerable degree. Bell and Adamson have shown that in transverse tests the results obtained by breaking bars of various sizes in cast iron from the same ladle of metal and simultaneously cast so that conditions are regular and constant, do not give in practice the figures related in accordance with the formulæ. Thus we are accustomed to compare the strengths of various irons which are tested in different dimensioned sections, as, for instance:—2 in. × 1 in. on 36-in. span, 2 in. × 1 in. on 12-in. span, or it may be, as it has happened in the writer's experience—a 2 in. × 1 in. on 36-in. span tested on edge with a bar of the same section tested on the 2-in. face on a 12-in. span.

The formulæ used for conversion are the engineers' formulæ used from time immemorial to determine load-bearing capacity of beams, and within limits are correct for wood, metals, and even stone and other materials, but it is interesting to note that a research conducted about two years ago and still in progress by Bell & Adamson has resulted in it being shown that very great discrepancies appear when such formulæ are applied to cast iron. Briefly, these investigators have shown that over a long series of experimental tests the larger the section the higher the breaking stress in actual practice. This is not, how-

ever, an invariable rule, as quite a number of results are given in which the actual test result is lower on the larger bars.

Preparation of Test Pieces.

The question of *the manner of preparation of a test piece* is one fraught with considerable difficulty. It is the first essential that the test bar shall be absolutely representative of the casting; it must, therefore, have the same thermal history. It may at first appear that the bar can be cast-on, thus becoming an integral part of the casting, but, apart from the problem of moulding it, there enters at once the likelihood that this procedure will weaken the casting, or itself be weaker than the casting in consequence of inequalities in cooling, or of volume, possibilities of draws and other contraction defects. The proportion of castings which will permit of a test bar forming a part without such disabilities is very small.

There is also a number of difficulties in regard to ensuring that a separately-cast bar shall be similar in all respects to the casting it represents. Again, it must have passed through precisely the same procedure and treatment, and be in section as near as possible to that of the casting. Neither method is ideal, but the separate casting of the test units is more generally practicable and more commonly relied upon. It is of greatest value when it forms the valuation of castings manufactured on mass production lines, as regularity of results from tests on successive casts should be a satisfactory guarantee of the strength and quality of the material in the castings themselves. The best and most reliable method of obtaining tests is to cut up a casting and make the test bars from it, and it is here that the tensile test comes in most useful, as a bar of about 6 in. by 1¼ in. can often be cut from the wall of a casting and machined into a test piece of 0.5 sq. in. in area with an acting length of 2 in., or if the section does not permit that dimension, 0.25 sq. in. area may be obtained, and quite a fair test for tensile strength carried out.

Seeing that the shortest transverse bar which can fairly be tested is 14 in. long so as to be tested on a 12-in. span, it is generally out of the question to consider the casting-on of such a test unit as an attachment of the casting, and it is certainly quite impossible to cast-on a bar which can be broken on a span of 36 in.

Even with the short test-piece which is required for a tensile test, great judgment must be used in arranging that both test bar and casting are not thereby impaired, and in general the founder should be supported in demanding that the test bars be cast alongside but not attached to the casting.

Tentative Specification Discussed.

The specification which has been published and suggested for adoption by the most interested institutions in this country asks in general for very moderate strengths in cast iron. All rectangular or square bars are ruled out, and the bars are to be cast in dry-sand moulds. (Suggested.)

While the disabilities of test bars with angular corners are admitted, it should be borne in mind that the standard test, as far as it existed in this country, has always been on 2 × 1-in. or 1 × 1-in. bars, and it is practically certain that, whether or no the round bar is adopted, the older tests will still remain in use. The square or rectangular bars are cast horizontally, and though requiring a degree of care are easier to mould than round bars vertically cast. Differences in dimension brought about by irregularities in moulding are more easily corrected than in round bars, and figures are more easily related to those of larger or smaller bars of square or rectangular section. A considerable advantage also accrues from the fact that they are cast horizontally, and may be made perfectly well in green sand.

On the other hand, the round bar for transverse test has some very pronounced advantages—a more regular structure is assured, chill is equally distributed over the surface, and its shape rules out possibilities of internal strains.

It is, however, a more difficult bar to mould, and cast in sets of four, bottom-poured in a box, the bars give less regular results, *i.e.*, bars of the same set show considerable variation in strength, the percentage of wasters from dirt and blow-holes is higher, and, further, the specification lays down that the tensile test shall be machined from the lower end of the round bar after testing; while this last factor may generally operate all right in practice, it is not so sound in principle, as one test one bar should be the rule.

The carrying out of the transverse test further brings in some points in favour of the straight-sided bar. It lies easily on knife-edges or radiused supports. If it is out of shape it is easily noted and can be rejected. The loaded knife-edge bears over 1 in. of surface, while in the round bar it has only contact at a point in the circle, and a certain degree of indentation which may affect the result is almost inevitable. The round bar also may not be quite true, and a very small degree of ovality will naturally alter the result.

In the case of the smallest suggested round bar, 0.875-in. diameter, this appears too sensitive a bar, both in moulding and testing, to ensure concordant results, and it has been found that the tensile test pieces of 0.25 sq. in. area, 0.564 in. in diameter, which are machined from this bar generally give low figures.

The testing machines generally in use for transverse testing are all adapted to square or rectangular bars; many of them cannot, without alteration, be used for round bars.

The Tensile Test.

A great deal has been said and written in criticism of this test in conection with cast iron. Undoubtedly this is in part due to the widely differing results given by different machines and operators. The writer is convinced that a great deal of controversy on the question is misdirected, the material often being blamed for defects in reality due to the method of handling the test. The size and design of the test piece is of impor-

TABLE I.—*Tensile Influence of Size of Test-piece Cast.*

No.	Size of Bar.		Broke at Tons per sq. in.	Per cent. Reduction from area as cast.
	As cast.	Test-piece.		
	In.	In.		
1	0.75	0.584	18.0	43.38
2	1.00	,,	15.5	68.19
3	1.25	,,	15.0	81.27
4	1.50	,,	14.5	85.84
5	2.00	,,	13.0	92.04
6	2.50	,,	12.5	94.03
7	3.00	,,	12.5	96.38

tance, and some results obtainable by Bell and Adamson indicate the necessity of relating the size of the test piece to that of the bar from which it is machined.

Perhaps the feature of greatest effect is the method of gripping the test piece in the machine together with the control of the applied load, which, especially at the outset, must be both gradually and carefully applied so that the aligning mechanism can come smoothly into action.

It is found that in test pieces with a parallel acting length fracture most frequently occurs at or near the radiused shoulder. This is due to the following reasons:—(1) Imperfect alignment; (2) faults in machining; (3) friction at grips; and (4) the granular and inelastic nature of the metal.

None of these causes can be entirely eliminated, but the first three must be minimised by special care in preparing the test piece and in mounting in the testing machine. The nature of the metal and the inherent weakness in a metal of crystalline structure cannot be ruled out, for in applying tension stress to a bar of varied section the larger section will maintain the load while the smaller is being distorted, and one of the effects of this is to locate the fracture at the point where the section is changing in diameter. This may, of course, be upset where a slight local weakness exists at any other portion of the acting length. The design of the test piece is usually such as to localise, as far as possible, the point of fracture to the centre of the specimen.

This, however, has some drawbacks. The testing of special irons and those of a special tough character should be done under conditions that allow of elongation being observed, or at least conditions that make it possible to prove whether or not there is any degree of extension. This makes it essen-

tial to have a parallel of reasonable length with dots marked just inside the shouldered points to enable measurements to be taken. Even then it is desirable to have the acting length of a 0.798-in. diameter test piece, 4 in. between dots, which constitutes a rather delicate test bar and brings about other undesirable factors.

Factors of Safety.

In connection with specifications it should be borne in mind that the actual strength of the metal in a casting necessarily varies at different points, and that the stresses in a complicated casting will materially reduce locally the strength as indicated by the test bar, however close may be its relation to that of the metal in the casting.

Engineers, knowing this fact, generally make allowance by thickening up sections, increasing weight and bulk in the casting, often unnecessarily, if the design were considered in the light and with a knowledge of the properties of cast iron and its behaviour during casting and cooling.

Frequently the means adopted in designing to give locally added strength are such that the foundryman and the metallurgist would at once condemn, as introducing elements of stress which result in effects opposite to that desired; fillets, ribs, bosses and the like often necessitating the insertion of chills, are generally obstacles to sound casting and frequent causes of wasters. Above and beyond this, an element of uncertainty as to the internal condition of a casting and the very reasonable doubts as to its homogeneity in texture and its allowed weakness under shock make it essential that a large safety factor should be allowed.

The safety factor, always a prominent feature in specifying strength and dimensions of section in steel and non-ferrous metals, is always a very generous allowance in the case of cast iron, and may be anything up to ten, but where a high strength cast iron with the good casting qualities claimed for certain of these special products is used, designers should be able to decrease dimensions and even be satisfied with a lower allowance as safety factor. This condition will no doubt come about, as confidence is inspired by the continued high performance of these irons in practice and under test. Nothing will contribute more to this confidence than the sustaining of satisfactory fatigue and shock-resistance tests. Such tests are not yet standardised or generally adopted, and though it is thought the question is being considered by one or two authoritative bodies, it is hoped that definite tests and methods will be eventually agreed upon as standards, as, for instance, in the case of hardness and the Brinell test.

Improvised Tests.

It is often that useful information as to the load-bearing capacity of certain castings or parts can be obtained by a direct test, transverse or tensile.

Steel bolts are a typical case, and the writer has taken numerous tests to determine the strength of these by introducing special holders and reducing the diameter of the bolt below that of the lowest limit of the thread.

Transverse tests of tube walls are also taken by cutting a strip from a tube and testing on a 12-in. span. Although results in this case are not given in the usually expressed manner, the breaking load of the metal in the tube is ascertained by this empirical test, and comparative results of interest and value are obtained.

A certain firm manufacturing tubes by a special process take a tensile test of rings cut from the tubes by pulling the ring asunder. It is claimed that the true tensile strength of the metal is obtained by the following formula:—

$$f = \frac{Wd}{cbt^2}$$

where C = constant = 4,000.
W = breaking load in lbs.
b = breadth in in.
t = thickness in in.
d = mean diameter in in.

A considerable number of tests on these lines have been carried out by the writer on economiser tubes of various composition, and the results obtained, giving useful information, included rings cut from tubes centrifugally cast, and these, though among the best, did not give higher figures than certain of the others.

This particular test belongs to a class which should be called empirical rather than absolute, the results obtained, while strictly comparable with rings of the same dimension and of similar material being accurate within limits, forming a basis of comparison, but the element of distortion will at once bring in factors which make it impossible to compare elastic with non-elastic metals.

The testing machine may often be used to ascertain directly the strength in tension or transverse of parts or castings, and a little ingenuity in devising special attachments and fittings very greatly extends its uses. Such tests, while having a value of their own, are quite separate and distinct from the standard and universal tests, the results of which in their statement imply values relative to all types of material.

Conclusion.

A great deal has been omitted in this Paper which might have extended the interest, but it has been the writer's intention to deal rather with the principles of testing and the special care and precautions necessary in applying accepted methods of testing to cast iron, to co-relate the tests and consider their values as applied to a material of which we are beginning to learn what a large amount there is yet to know about, and in this connection it is of the greatest interest to note that metallurgists are beginning to devote serious attention to cast iron, that a special research body is devoting all its attention with no small skill and equipment to its study and development, and the engineering world owes no small debt to the I.B.F., in that they have constantly kept the problems of the ironfoundry before them, and have been instrumental in publishing, broadcasting and thrashing out the practical side of this oft-abused and little-understood subject.

Company Meetings.

Wm. Cooke & Company, Limited.—At the annual meeting of this company, the chairman (MR. H. C. ELSE), in moving the adoption of the report and balance-sheet, said that the year had been a bad one for trade, and, owing to the fact that the works had not been fully employed, they could not recommend a dividend. The affairs of the company were quite sound, and it only remained for normal conditions to be resumed for William Cooke & Company to enjoy their former prosperity.

Falkirk Iron Company, Limited.—The sixth annual meeting was held in London recently. CAPT. H. J. KENNARD, R.N. (retired), managing director, presided. The chairman said:—During the year under consideration several important improvements have been made in the methods of manufacture both at the works at Falkirk and at Sandiacre. I am glad to be able to say that these improvements have proved satisfactory, and have given immediate results in larger and better output. We shall continue to pursue this policy. At the moment we have in hand at the works very considerable alterations to our cupola practice, and this we have every reason to believe will also facilitate production. In regard to our subsidiary companies, H. E. Hoole & Company, Limited, Sheffield, have had a satisfactory year. The depressed condition of industry generally, however, militates against any great development there. The Excelsior Works, at Sandiacre, have considerably increased their output, nd are now thoroughly well established. The works and plant there have been considerably improved. We are again able to congratulate our friends the Durban-Falkirk Iron Company, on a very satisfactory year's working and continued progress. I am glad to say that we have with us here Mr. Walter Greenacre, the chairman of that company, and I feel sure we are all gratified that such excellent progress has been made by both concerns since we became associated. We have made satisfactory progress in regard to the provision of houses for our workpeople at Falkirk, and we hope to have the first instalment of sixteen occupied soon after the holidays.

HERR EDUARD SCHUERMANN, the inventor of the cupola bearing his name, died recently at Dresden. He was 73 years of age. He was connected with foundries all his life, and had worked in Belgium, France, United States, and Great Britain. It was only some nine years ago that his cupola was first tried out.

The Story of Hunslet Foundry.

By E. KILBURN SCOTT, A.M.INST.C.E., M.INST.E.E.

The artificers who helped to build Kirkstall Abbey in the twelfth century would be the first to work iron in Leeds, and although it is possible they did so at Kirkstall with charcoal as fuel, it is more than likely that they also employed the coal which outcropped at Beeston and Middleton, for there was a bridle path from the Abbey to Beeston.

When the Knights Templars were at Temple-Newsum they would need artificers accustomed to working iron to take care of their armour, etc., and in Foundry Lane, which is near, we have a present-day reminder of the fact.

In 1669 coal was being worked at Middleton on a scale sufficient to justify the striking of special coins, because a halfpenny found in Bramley has on one side "Francis Conyers of Middleton in Yorkshire, 1669," and on the other "for use of ye coal pits."

In the "Annals of Yorkshire" there is an account of a murder in 1678 of a *colliery owner* named Leonard Leurr, who had filled the office of minister of Beeston Chapel during the time of Cromwell, and was therefore a prominent man.

These references are given in order to show that a traditional skill in coal mining and iron working was growing up in Leeds, and especially in the South, long before the commencement of the industrial era at the beginning of the nineteenth century.

An interesting document of that period is the Polling List of the Parliamentary Election of 1807, a very critical year in English history, because of the Napoleonic wars. In it there is a record of the responsible burgesses who went to York to vote, and it gives their addresses and trades or professions.

The Hunslet polling list has the names of two millwrights, namely, John Jubb and David Trickett, and three ironfounders, John and William Gothard, and — Salt, showing that the various people who made engineering history in Hunslet had not yet come on the scene. As a matter of fact, most of them date from after the *middle* of the last century.

In the Holbeck list there is Matthew "Mirror" (*i.e.*, Murray), described as an engineer, and the only one in the Leeds district to be so described, also his partners, James Fenton and David Wood, who are called ironfounders. In the Leeds polling list there is also an ironfounder called Lister, who was for a time a sleeping partner of Fenton, Murray and Wood. His name appears on a document which is in the Matthew Murray Centenary Exhibit at the South Kensington Museum.

Matthew Murray was really the "Father of Leeds engineering," because it was he who first originated in Leeds the design and manufacture of spinning machinery, stationary steam engines, locomotives and of machine tools. The works of his firm, Fenton, Murray & Wood, in Water Lane, Leeds, were built about 1800 and had two foundries—one for green sand and one for dry sand moulding, with air furnaces to melt the iron, and a small cupola.

There were several other foundries in Leeds, and probably the oldest was that on Hunslet Moor, which the present owners, Denisons & Sons, Limited, weighing machine makers, have occupied since 1899, when they took it over from R. Kilburn & Sons.

The first particulars of Hunslet Foundry, of which there is documentary record are in an agreement dated August 27, 1772, which relates that the executors of Robert Howitt sell to Timothy Gothard, ironfounder, of Hunslet, and Titus Salt, cast-steel maker, of Sheffield, the foundry and hereditament and tenements, etc.

Assuming that the foundry was in existence for a period of, say, thirty years before 1772, then it has had a continuous existence of nearly 200 years, which probably makes it the oldest in the Leeds district, if not one of the oldest in Yorkshire.

The agreement, written on parchment, measures 3 ft. square, and is the property of Mr. Matthew Carr, a great-great-grandson of the Gothard mentioned therein. For over a century it was kept in an old Hall, on Carr Moorside, Hunslet, a Tudor building having mullioned windows and coats-of-arms over its large open fireplace.

Thomas Fenton, an ancestor of James Fenton, the financial partner of Matthew Murray, is believed to have lived there when he was mining coal at Middleton and Rothwell. In Batty's "History of Rothwell" it is mentioned that one of the first pumping engines in the country was put down by Thomas Fenton in 1750, and it was one of Emmett's inventions and worked on the atmospheric principle. This was before the time of Boulton and Watt.

The agreement is witnessed by Jas. Newport and T. Newport, and some of the wording reads right quaintly:—

"On the day and year first within written, full possession as well as of the Tenements & Hereditaments as also of the Goods & Chattells herein mentioned to be hereby bargained and sold, were given to the said Titus Salt, and the delivery of the key of the outer door of the said Tenements and of one hammer part of the said Goods & Chattells in the name of possession and seizen."

The Timothy Gothard who signed the agreement died in 1805, at the age of 82 years, and his share in the foundry descended to his son John, who purchased the other share from Daniel Salt, the son of Titus Salt, the signatory to the agreement.

This Daniel Salt was a drysalter and ironmonger (which in those days meant also iron merchant) in Morley, but he moved to Bradford and became a wool stapler and worsted manufacturer. It was his son Titus, born in Morley, September 20, 1803, who first made alpaca, founded Saltaire, and became Sir Titus Salt.

John Gothard died in 1824, and then his son-in-law, John Gledhill, carried on the foundry until his death in 1855. He had three sons who, by a singular coincidence, died in three succeeding years. After the father's death the property came to the three daughters, the eldest of whom married an Excise officer, and she was the mother of Mr. Matthew Carr.

As the daughters could not carry on the business they sold it in 1855 to the author's grandfather, Richard Kilburn, machine maker, of Holbeck, who had for some years been obtaining castings from the foundry. At the time his eldest son, Richard, was 14 years of age, and at school, but he was forthwith put into the foundry, and he managed it very successfully for nearly half a century.

The old foundry was famous for a special quality of iron almost like a semi-steel, which was used by many engineering firms for the high-pressure cylinders of hydraulic presses. This was partly made from old cannon taken from dismantled forts, etc.

The metal was melted in a specially constructed air furnace, then by an old-time character called Dave Hartley, who used to light up before 3 o'clock in the morning. When he died the furnace stopped, because no one could be depended on to start work at that hour.

The first Blenkinsop rack rails which were laid down on the old waggon way (built by C. Brandling in 1758) from Middleton to Hunslet, were cast in this foundry in 1811, and when they were taken up in 1862 the late Richard Kilburn used them as scrap. Specimens of the rails are in South Kensington Museum. The 3¼ miles of line, required about 1,000 tons of rails, and as there would be many breakages it was convenient to make them in a foundry that adjoined the line.

John Blenkinsop, the patentee of the rack railway, appears to have designed the first rail, which was preserved for over a century at Middleton, and now belongs to the Leeds Museum. It is 6 ft. long, and much cruder in design than the 3-ft. lengths of rack rail from the same railway which belongs to the Institution of Mechanical Engineers.

Rails of wrought iron first began to be used about 1820, and before then the problem was to make rails of cast iron strong enough to withstand the pounding weight of a locomotive and yet not cost too much. As the success of the Matthew Murray's locomotives depended on the strength of the cast-iron rails he had probably a good deal to do with the final design.

The Examination and Analysis of Cupola Slag.

By H. H. SHEPHERD.

That there are very few foundries where cupola control includes periodical examination and chemical analysis of the slag is well known; it is true not only of the foundries which do not possess a laboratory, but also of those which have at hand a well-equipped testing laboratory and the services of a metallurgist. As for the reasons for neglect of this branch of melting practice, first and foremost comes that of ignorance or lack of appreciation of the effects of slagging conditions upon cupola practice; secondly, the rather long period of time taken to carry out a complete analysis; thirdly, the lack of a laboratory or sufficient laboratory staff to deal with the work, for most laboratories are insufficiently staffed. Visual examination is, of course, far better than no examination at all, and ignoring the existence of the slag or regarding it as only a nuisance, and for the smaller foundry or that not having a laboratory it forms a satisfactory means of controlling as well as possible the slagging conditions, under the circumstances referred to, but where a laboratory is installed and the services of a suitably qualified person is at hand, those responsible for the melting plant should see that at least occasional complete analysis of the slag is made. Visual examination will indicate when too little flux is being used, and also to an extent, when too much is being used, but the latter is not detected as easily as the former, and usually, examination of the furnace lining is the better indication that too much flux is going into the furnace. Analytical examination will, however, enable one to detect both faults immediately and before any damage or any considerable waste has taken place. It enables one also to gauge to a nicety the amount of flux necessary to produce satisfactory and economical slagging and *desulphurising* conditions. The advantages that arise from proper slagging conditions in connection with desulphurisation has been clearly shown and proved by various authorities, including J. E. Fletcher, J. Bolton (U.S.A.), and Dr. T. Swinden.

To regard slagging—or the adding of limestone to the cupola charge—merely as a means of removing dirt, coke ash, etc., from the iron, is to be, almost profoundly, ignorant of the detrimental or beneficial effects which the slag formed, or the flux used, has upon the iron, and also upon the furnace itself. It is nevertheless quite a common occurrence to walk into some of the most modern foundries and find this condition of affairs. No one interests themselves in such a material as slag, so long as it is not found in the castings. The writer has seen loads of slag containing appreciable amounts of metallic iron in the form of pellets. There was also evidence of heavy iron losses by oxidation. If those responsible for the melting in that foundry—and it possessed a first-class laboratory and a staff of metallurgists and assistants—had had the smallest interest in the slagging operation of their furnaces there would have not only been a considerable increase in the melting efficiency, but also a considerable saving in iron; the iron would have been lower in sulphur; the furnace would have been much cleaner after the drop; and the lining would have seen longer life. For a slag to be representative of good slagging and desulphurising conditions it should contain (*a*) not more than 50 per cent. silica; (*b*) preferably less than 45 per cent. lime; (*c*) not less than 0.35 per cent. magnesia; (*d*) not more than 8 per cent. ferrous oxide; (*e*) not more than 3 per cent. manganous oxide; and (*f*) not more than 12 per cent. alumina.

The following figures are of the actual analysis of a slag from an ordinary grey iron cupola. This slag ran and wooled freely and was of an olive-green colour in the lump and an almost grey colour in the powder:—

Silica = 47.20; lime = 37.00; alumina = 7.51; manganous oxide = 2.10; magnesia = 0.22; ferrous oxide = 5.17; and sulphur = 0.50 per cent.

A further example may be given, which is the analysis of a slag produced by a cupola making malleable iron:—

Silica = 52.60; lime = 23.15; alumina = 12.50; manganous oxide = 0.60; magnesia = 0.33; ferrous oxide = 10.02; and sulphur = 0.70 per cent.

The second example, that of the slag from the malleable iron, is not that which is indicative of good slagging conditions, the lime content being too low. As a result of the analysis and other examinations the amount of flux on this cupola was increased, which immediately gave improvement in the slagging conditions, and the colour changed from an almost black-coloured slag to a rather dark green, while the iron following the alteration in the amount of flux used, was much cleaner, a most important consideration in connection with the manufacture of malleable castings, since the metal does not retain its fluidity so long as does grey iron.

Analytical Methods.

There are many published methods for the analysis of slags, some are good, whilst others are not at all reliable, probably because there are not sufficient details given of the procedure to ensure one obtaining accurate results. The method to be described, and for which originality is not claimed, is the result of selecting from several of the published methods which have been found by the writer to give accurate results. To speed up the analysis, modifications have been introduced. The resulting general method will be found to give not only accurate results, in so far as every-day cupola practice is concerned, but also to enable one to make a complete analysis in a reasonably short time.

Sampling.

The sample must be truly representative of the whole of the slag of a particular melt. As the composition of the slag varies rather considerably throughout a melt, the sample should be taken about half-way through the melt by collecting it, while it is still flowing from the slag notch, in a warm sample spoon or ladle. Where the melt is such that the slag hole is not opened until well after the middle of the melt, then collect the sample shortly after the opening of the slag hole, so that a clean representative sample is obtained. Crush each of the samples in a chilled-steel or hard-iron mortar to about $\frac{1}{4}$-in. mesh. If it is noticed that any one or all of the samples contain pellets of iron, carefully extract these with the aid of a strongly-magnetised hand magnet and weigh them; weigh also the partially-crushed sample. The metallic iron can then be calculated as a percentage, and, with the knowledge of the approximate weight of slag formed during the melt, it is an easy matter to ascertain the amount of metallic iron lost. In some cases this amount is very considerable, and usually the appearance of such pellets, particularly in large amounts, indicates that the melting practice is at fault, and that fault will usually be found to be due to bad slagging conditions.

Having roughly ground each sample, quarter it until a quantity weighing about 30 grammes is obtained. Grind this in the same mortar, and with the aid of an agate mortar also, till the whole weight taken passes a 90-mesh sieve. Finally it is ground to almost flour fineness in an agate mortar. It will be found that a sample prepared and ground in this way will soon decompose under the action of heat, and the alkalies which are used to bring this about.

There is only one reliable method of decomposing cupola slags, and that is by fusion with alkalies in a platinum crucible. Figures resulting from attempts to analyse this material by the acid treatment of the sample as the means of decomposing it are very misleading, because the amounts given as "Siliceous matter" as a guide to the silica contents are usually abnormally high, while the remaining figures for the other constituents are abnormally low. The writer has carefully examined the results of treating samples of slag with repeated boiling and evaporation to dryness with mixtures of acids, such as aqua regia, but the resulting residue when thoroughly washed, dried and then examined under a magnifying glass, clearly showed that the actual attack of the acids or decomposition of the material was only partial.

XUM

Procedure.

Weigh out 0.50 grammes of the powdered slag and intimately mix it with 2.50 grs. each of potassium and sodium carbonates (anhydrous) and 0.30 gr. of powdered potassium nitrate. The mixing is best done on a piece of dark-coloured glossy-surfaced paper. After mixing, transfer to a covered platinum crucible. Heat the crucible and content for about ten minutes quite gently, so as to avoid spattering, and then strongly for 20 to 30 minutes. Whatever the means of heat and decomposition adopted, the stirring of the mass during fusion should not be omitted, as this action serves to wash from the crucible sides any undecomposed matter into the liquid mass. The writer has repeatedly and successfully decomposed ganister and similar siliceous materials by the means of the flame from two ordinary ½-in. bunsen burners in from 15 to 20 min.

(*To be continued.*)

Metal Shrinkage.

By J. H. List.

In the past many well-known metallurgists have dealt with this question, yet it is a subject that can still be treated of usefully, as it undoubtedly causes many wasters. Also in many shops it does not receive the attention it warrants. Shrinkage is the outcome of unequal cooling of the metal. This may be caused from different temperatures of the component parts forming the mould, such as a dry sand core which may be a different temperature from the green part of the mould. Consequently the varying components forming the mould absorb more heat than others and at different rates. There are many well-known methods of endeavouring to overcome this fluid shrinkage, such as by the use of denseners, chills

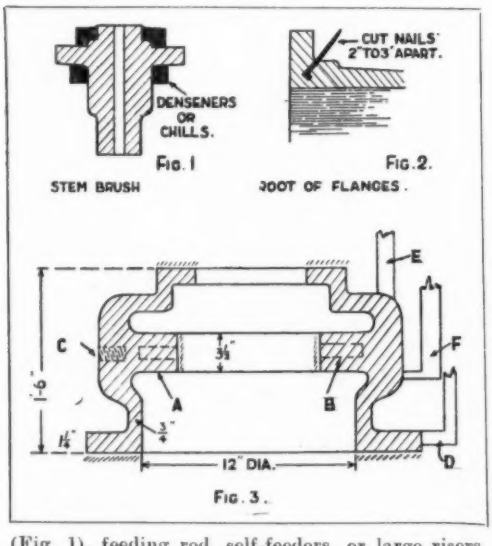

Fig. 3.

(Fig. 1), feeding rod, self-feeders, or large risers. Then there is the method of nailing moulds in the thick portions (Fig 2) where the nails project into the molten iron, with the object of holding up the iron. Additional effects are caused by the distribution of the runners entering the moulds at opposite points. Exhaustive tests have been made with the object of preventing this shrinkage in large shaft couplings by the means of chills and denseners, but the trouble was not overcome. The writer wishes emphatically to assert that in none of the foregoing methods, including extensive feeding by the rod, can this shrinkage trouble be said to be overcome definitely. It is possible to produce some castings from a given order quite sound by using one or more of these methods, but one cannot rely on having all the castings sound. There is, however, one method whereby good castings, despite this shrinkage trouble, can be produced. For this purpose, therefore, and as an example, the writer cites a job which has recently come under his direction. Many of the foregoing methods had been tried with only very limited success. Some good castings were, however, produced.

The least sign of shrinkage in this casting rejected it, and consequently this is a subject which needs a maximum of attention. The casting in question is shown in Fig. 3, and forms part of a special valve. The spongy place is usually in the thick place marked A. The casting is machined where shown cross-hatched. A recess is bored out as shown by dotted lines B, whilst there is also a hole tapped in various places as at C. These have been made and run at the bottom flange as shown at D, and arranged with three risers 2-in. diameter as shown at E, and these were well fed with the feeding rod. This method, however, only produced 10 per cent. good castings. The best method, however, after many trials proved to be one by which the casting was run at two places in the middle portion opposite each other at F, and providing a riser at the top flange. The diameter of the downrights was ¾-in. diameter, but the actual gates into the mould are only ⅜-in. square. An important feature is that the mould is cast with white hot metal. It will be noticed that the metal entering the riser will be practically set. The object of this method is to institute conditions that all the casting sets almost at the same moment as the mould is full. This overcomes fluid shrinkage practically entirely so far as this casting is concerned. As can be seen, the mass of the metal is almost set before it is finished running up, and is being fed by the incoming metal, whereas below the runner line it has a chance of setting. It cannot, of course, be laid down as a hard-and-fast rule that the small runner method will do for every class of casting, but without doubt it may be applied to many and will give good results. The metal must be white hot, otherwise misruns will result.

Obituary.

Mr. John Smith, the general manager and director of the Woolston and Southampton works of John I. Thornycroft & Company, Limited, has died at the age of 52 years.

The late Mr. Percy Stubbs.

At the advanced age of 82, the death took place recently of Mr. Robert Hindle, at his residence, "Woodstock," Old Colwyn. He formerly belonged to Ashton-on-Mersey, and was managing director of John Hetherington & Sons, Limited, Manchester.

Mr. Percy Stubbs, a director of Joseph Stubbs, Limited, Mill Street Works, Ancoats, Manchester, died on July 7, after a short illness. Mr. Percy Stubbs was the youngest son of the late Mr. Joseph Stubbs, founder of the firm. Mr. Stubbs was originally trained in the foundry, but was eventually transferred to the commercial side of the business. He is the brother of Mr. Oliver Stubbs, past-president of the Institute of British Foundrymen.

Patternshop Foremen and Charge Hands.

BY JAMES EDGAR.

In the great majority of British patternshops there are probably not more than twenty men employed, but in a number of the larger electrical and shipbuilding shops there are frequently over a hundred men, and in shops of this size the foremen lessens his own responsibility by promoting the most highly skilled men to be his chief assistants. Let it be said that the efficiency of a patternshop depends in very large measure on the foreman. In a large shop his position is different from that in a small shop where only a few men are employed, although the small shop foreman may really have the more onerous position. The large patternshop is frequently divided into departments, and the foreman is, to a great extent, simply an organiser. His duties will chiefly consist in estimating for work, preparing progress reports, keeping in close touch with the drawing office, and he is, more than any of his assistants, the disciplinarian. Some foremen in large shops keep a small staff of men under their direct supervision, giving the drawings out to them, and checking their work. The chief gain from this practice is that it retains the men's respect for the foreman as a craftsman, and it also enables the foreman to learn at first hand who are the dependable men in the shop for any kind of job. What is foolish, however, is for a foreman, responsible for, say, a hundred men, to attempt to take direct charge of a large job on which perhaps twenty men are employed, as continual supervision is necessary, and the first duty of a foreman, which is the proper organisation of his shop, is almost sure to be neglected.

In a large shop an assistant foreman is practically a necessity, and indeed there can be two or three, while in addition there will be several charge-hands or checkers. In many shops the chief foreman is not consulted about construction at all, except when a modification of a design is thought to be advisable, or when he is called in on some point relating to moulding methods. It is surely wise practice, however, before passing drawings to the assistant foreman or to the charge-hands to discuss constructional details.

Labourers' Duties.

In the average large patternshop there are four different classes of labour, the journeyman patternmakers, apprentices, the machinists and the labourers. In a well-organised shop, the duties of these various elements of labour are very clearly defined, except in the case of what are called unskilled labourers. In large shops there may be one labourer who may function as a store keeper, and who can read an arrangement or detailed drawing with fair skill and not only look out the main pattern for a repeat job but also the necessary details for mountings and covers in the case of valves. The most useful type of man for a patternshop labourer is one who, while skilled in some craft, has had to give it up for health or other reasons. Any experienced patternmaker will readily acknowledge the great assistance that is rendered to a shop by an intelligent labourer who is something more than a mere floor sweeper. Therefore it is a mistake to assume that the labourer is worthy of little or no consideration when discussing the various elements that contribute to the efficiency of a patternshop.

If organising ability is of paramount importance in the large shop, other qualities of equal importance are necessary in the patternshop employing only a few men. There are very few now of the older type of foremen patternmakers who have had a millwright training, and are capable of designing a set of engines, although at one time such men were fairly common. The foreman in the small shop, especially if he is a working foreman, holds a very onerous position; in addition to estimating for work, in many cases he sets down work on the shop drawing boards, discusses constructional details with the men, tells the apprentices, checks and passes work for the foundry and may also attend to the moulders in the foundry.

Working Foremen Unprofitable.

Speaking from considerable experience, it is the writer's opinion that it is seldom profitable to have a working foreman, as he is in too continuous and close touch with the men to obtain discipline, and he cannot possibly do justice to his work. The most that should be expected from a man in such a position is the setting down of the larger jobs. The average small shop foreman has no one that he can consult about work and must, therefore, be self-dependent. When a job that is larger than usual comes he may have to trust an apprentice with it, watching him closely. It is rather surprising that so few small shop foremen ever secure positions as foremen in large shops, and it is unfortunate, because if the class of work turned out is good the small shop is undoubtedly a splendid training ground, especially as many of these men have been charge-hands in large shops before securing positions as foremen. In a jobbing patternshop, for instance, where estimating for work is often on quite unsystematic lines, the foreman has frequently to turn out work in the shortest possible time, and there are occasions when a price has to be quoted for a complicated pattern and core boxes almost at a minute's notice, and even when the estimator has had considerable experience he cannot be sure that the price quoted is on the right side until the work is nearing completion.

In patternshops where anything from forty to one hundred men are employed, charge-hands, in addition to assistant foremen, are necessary, and the effect of this policy is a virtual dividing of the shops into different departments. Sometimes it is possible for a patternshop of the larger size to get along very well without recognised charge-hands if the class of work is small, but on the other hand a shop with twenty men doing large work will require one or two charge-hands. When only a few men are employed, there is invariably one man on whom the foreman can more or less depend. This man is in no wise a charge-hand, although he may get some extra remuneration; usually, however, his reward is in the form of regular employment.

Defects in the Charge-Hand System.

Where a charge-hand system is in operation the men do not, except in special cases, set down their jobs, but usually receive the drawing board from the man in charge; indeed, in some shops, the men do not even see blue prints. This is a questionable policy, because so much can be learned from an examination of an arrangement drawing and, in addition, the man has not the same interest in his work if he does not know for what purpose it will be used. This, it may be said, is simply another phase of the undoubted truth that the craftsman who has a knowledge of principles, works more intelligently and is, therefore, of more value to an industry than if he is a manual worker and nothing else.

Alternative Systems.

In some shops the charge men are described as leading hands, which term really defines different types of supervisors. Whereas a charge-hand may have many large and small jobs going on simultaneously, the orthodox type of leading hand sets down a large pattern, and is responsible for more than one job at a time. In the case of the charge-hand he has several large patterns under way, but invariably depends on one man on each job, guiding and assisting the others.

In some patternshops, as an alternative to charge-hands, there are checkers. These checkers are employed checking and passing patterns and core boxes for the foundry. The responsibility for different classes of work should be placed on different checkers. This is a better system than the method which is sometimes adopted, when the foreman apportions the work among the checkers quite independently of the engine number or the type of job. The checker ought to concern himself with the moulding of the pattern as well as merely comparing it with the drawing, although it may not be often necessary for him to criticise the construction. What must receive his special attention are machining and contraction allowances.

The charge-hand on a big job must have a fair

degree of organising ability. In a marine shop, for instance, when a turbine casting is started, a clever charge-hand will so dovetail the work that it should not be necessary to train men to other jobs until the pattern is quite complete. Further, it is also possible, by close and unobtrusive supervision, to minimise the final inspection and checking by examining the various parts as they are made. When giving out work, the charge-hand patternmaker should either state how he wants a job constructed or discuss it and modify his view, if he considers it advisable; which is the better method depends on circumstances. Patternshops doing a standard class of work usually evolve what are considered by the foreman patternmaker and the foreman moulder the most suitable methods, and shop practice is determined in this way.

Staffing Patternshops.

Need it be said that if the best results have to be obtained from any patternshop there must be a very complete confidence between the foreman and the chargeman, and this depends on whether or not they can temperamentally dovetail into each other. It is surprising how men, who appear unlike in many respects, have certain sympathies in common which enables them to work together. It appears desirable in most cases that foremen should be consulted in the selection of their supervisory assistants, even if they have not an absolute right of choice. This is sometimes used as an argument for introducing strangers when positions have to be filled, but it is not always wise to introduce an assistant foreman with no particular knowledge of the class of work for which he is required to co-operate with a foreman who has this knowledge, as naturally, good relationship between the heads is essential for the smooth and efficient operation of any shop.

The position of the foreman patternmaker is perhaps one of the most difficult in any engineering works. There is considerable difference in skill between craftsmen, and this is naturally unavoidable in a type of work with which there are no automatic machines. Some men are experts with tools, but almost devoid of initiative. They appear to lack the ability to visualise a finished casting, consequently they cannot decide on methods of construction and moulding, yet they may be hard workers and, within limits, profitable men. In small patternshops with two or three men there is no room for inefficiency, and it is never wise to give men jobs beyond their capacity. The foreman is, or ought to be, too busy a man to be continually guiding, and it is not usually possible to reserve the difficult work for one or two men. The best type is he whose abilities are balanced. Some men readily grasp the essentials of a job, yet are very inferior in the use of tools. It is a fact, however, that the inferior tool worker may make a satisfactory charge-hand.

In large machine tool, marine, or electrical shops there is room for every type of patternmaker, and although firms naturally want good all-round men they have to hire a proportion of them who are not. Where the work is of very fine nature or for repetition castings, whatever other qualities the workman may have, it is essential for him to be good with tools. There is a big proportion of internal-combustion engine work that is comparatively simple, and accuracy and good finish are the qualities essential for this class of work. It is a truism that the best type of patternmaker appreciates machinery, and will devise all sorts of ingenious jigs to minimise labour. Tactful foremen can often give a lead, so much so that in some shops jigs for the saws and other machines are very much in evidence.

Patternmaker or Machinist?

Some years ago there was a tendency to take machine work out of the hands of the patternmaker altogether and give it to a specialised machinist. There is something to be said both for and against this. It is to be decided whether there is sufficient work for one man sharpening all his time. In the writer's opinion, for overhauling and sharpening machines, a trained machinist is often better than the patternmaker, although there is reason for stating that the patternmaker who has obtained experience in machine attendance is the superior. It is undoubtedly true that he is a most efficient machine user. It is sometimes forgotten by works managers that the patternshop differs from other woodworking shops, because invariably just one or two pieces of timber are required of a certain shape, and they must be to accurate measurements, whereas other woodworkers may have to consider appearance primarily. In the patternshop, also, more awkward shapes have to be dealt with on the bandsaw; for instance, a patternmaker has to enter into a considerable explanation if a machinist is doing the cutting, and, in all probability, has to stand by while the cutting is being done. Therefore, where a patternmaker or machinist is employed for sharpening, the patternmaker ought, in most cases, to do his own cutting. This machine question is of the greatest importance, as the production costs are considerably reduced if the saws, planing machines, etc., are in good order and the greatest use is made of them. One of the important problems of the small patternshop is the maintenance of the machines in good condition. In such shops it is often anybody's business to sharpen the saws or grind the planing-machine irons, and too often this means that it is nobody's business. In the smallest shop it is advisable that one man should be allowed to allocate so many hours a week to keeping the machines in order.

Apprenticeship Training.

The chief concern of any foreman patternmaker is the training of his apprentices. The system of having an apprentice supervisor for the whole shop is a good one, but it is seldom practicable. The apprentice patternmaker, like the apprentice moulder, has a great deal to learn during the apprenticeship years, because there are no one-operation men in patternshops. A common subject of discussion is which is the best type of shop in which to serve an apprenticeship, and this is very fatuous and foolish talk. If the apprentice gets a grounding in principles, he is fortunate, and first-class craftsmen graduate from motor shops and marine shops, small and large; indeed, some of the best patternmakers are trained in jobbing foundries, where very little new or important work is ever seen. The best training for an apprentice is the practice of giving him tasks which are just a little beyond him, and this is usually profitable for the employer; indeed, if a foreman takes his apprentices in hand properly they should be profitable almost from the beginning of their apprenticeship. It is a recognised fact that in some shops the apprentices are uniformly good and in others they are uniformly bad, the reason for this being that some foremen realise the value of apprentices, while others regard them as more or less a nuisance.

The time-honoured custom still survives in some patternshops of placing an apprentice with a competent and capable craftsman for the first few years of the apprenticeship, and if the man is of a good type it is a satisfactory practice, because the apprentice is kept in close touch with good methods and learns not only how to do things, but why he does them. If, on the other hand, discrimination is not exercised, lads are mated with men of ordinary ability or poor character, and the result is likely to be disastrous. The influence of the foreman on the apprentice should be considerable, and it is always possible for the foreman patternmaker to take a direct and active interest in his lads. In all cases where it is or is not the shop practice for charge-hands to set down work the apprentices should do their own drawing, in order, among other things, that they may get a full understanding of machining and contraction allowances. Perhaps the most important requisite for a patternmaker is a knowledge—one might almost say a practical knowledge—of foundry work, and many foremen neglect this part of the apprentice's training.

The whole subject of apprentice training has a greater bearing on the welfare of the industry than is often recognised. The wise foreman will see that his apprentices get an insight to as many different classes of work as possible, because it is only in this way that confidence is gained.

Modern Induction Furnace Brass Melting Practice.*

By G. F. Hughes and P. L. Green.

A study of the existing prints of the seventeenth century brass founders will reveal casting equipment and methods not radically different from methods and equipment used up to ten years ago, in contrast to the very evident advances in the working of the cast metal. Fuels, furnaces, tongs, moulds, crucibles, and miscellaneous shop equipment show a surprisingly small degree of change. Handling methods have been improved. In general, however, the differences appear to have been along the line of minor changes in existing equipment rather than in the introduction of basically new equipment methods.

In 1916, however, the brass casting shop saw the introduction of a device which at once marked it as a thing apart from its progenitor of the Middle Ages—a veritable renaissance of the art of brass mill casting. The genius of the electrical engineer and the refractory manufacturer combined to make possible the modern vertical, closed-channel type of induction furnace. The first installation on a production basis was made in the casting shop of the Bridgeport Brass Company in October, 1916.

The theory of operation of the furnace involved only well-known electrical principles, the transfer of power by electro-magnetic induction, that is, the transformer principle, and the heating of a resistor by the passage of heavy current. Development work on the furnace brought to light, however, several hitherto little suspected and unused truths concerning the mechanics of fluid and short-circuited conductors, which were promptly put to work to secure more effective circulation of the molten metal.

The chief difficulty in the development of the furnace lay in the embodiment of these principles, new and old, in a practical heating unit working under the very definite limitations of strength and temperature imposed by the refractory and insulating materials available. The demands of the induction furnace on a refractory are in many respects the most severe made by industry to-day.

It is seldom that a machine comes to its task equipped with as many inherent advantages for that particular task as does the induction furnace.

It should be said at once, however, that the best pit fire casting practice can produce brass the equal of that produced by the electric process, but it is equally certain that average pit fire practice will not always produce metal to equal average electric furnace metal. The replacement of an always uncertain element is a factor of importance in brass melting. Brass is a product demanding the nicest care in its manufacture. The alloy must be carefully charged, uniformly heated at a correct rate, thoroughly mixed, kept free from contamination, and poured at the correct temperature and rate. The induction furnace accomplishes all of these essentials admirably, besides possessing other advantages of prime importance to the manufacturer of brass mill castings.

Some furnace men cannot mix the charge as well as can the electric furnace. The furnace mixes automatically and steadily throughout the entire melting cycle without undesirable interruption in the heating rate. This makes for a continuously uniform mixture, the chances of improper mixture being further reduced by the fact that each charge is mixed with an already molten charge of at least equal weight, thus averaging out any slight errors of mixing that might occur.

In common with most electric heating devices, the induction furnace is susceptible of every accurate temperature control. Working with a uniform grade and weight of charge, the complete melting cycle from the initial charge to the pour at a given temperature will only vary by a few minutes throughout the run, with a correspondingly uniform power of consumption for each pour. Thus the k.w.h. meter and the clock may both be used to advantage as temperature indicators. The action of the furnace ammeter as the end of the cycle approaches is a reliable temperature guide. The construction of the furnace is such that pyrometric control is rendered easy and accurate. Visual judgment of temperature is likewise rendered easier and more accurate by the absence of the white-hot bed of coals surrounding the crucible, and by the fact that the metal is brought up closer to the eye of the observer.

Not the least of the advantages of the induction furnace, an advantage shared in common with all types of electric furnaces, is the improvement in working conditions effected. Modern induction furnaces are so effectively insulated that heat radiation from any part of the furnace walls is barely perceptible.

The virtual elimination of zinc oxide fumes, or "spelter smoke," is a factor of even greater importance. Since the installation of the electric furnace in the authors' works not a single case of "spelter shakes" has been brought to their attention. This condition is reflected from another angle in the reduction of zinc loss from at least 1½ per cent. to something under ½ per cent.

Metal produced under the conditions outlined in the above paragraphs cannot fail to be satisfactory to the fabricating mills, and this has been proved to be the case.

Cost Data.

Under conditions of 24-hour operation, 7 days a week, direct labour-man-hours per ton of metal should not exceed 4, based on an average of one man per furnace unit, rated 50 k.w., and producing 12,000 lbs. of metal per day.

At a high brass melting rate of 190 to 200 k.w.h. per ton, including electrical and metal losses, and an assumed current cost of one penny per k.w.h., fuel costs are in the neighbourhood of slightly under 16s. 8d. per ton.

One of the most striking savings is found in the item of refractory cost. The total cost of lining and preheating a 50-k.w. furnace, including cost of making and installing transformer, and allowing a reasonable overhead, in the experience of the writers, does not exceed £30. A conservative estimate of the average life of such a furnace in continuous high brass operation is 1,500,000 lbs., many furnaces exceeding this figure. This means a lining cost of 10d. per ton, an almost negligible cost item in the total manufacturing cost of the product.

Changing Composition of Product.

Among the possible disadvantages of the furnace have been listed the necessity of starting with a molten charge, and the difficulty of changing from one alloy to another when necessary. In the operation of a modern large casting shop the above are not serious difficulties. When a new furnace is to be put in service there is always a furnace of similar or nearly similar alloy available to furnish the molten charge. With a large order balance, it is possible so to operate the furnaces as to keep a given furnace on the same mixture almost indefinitely. When change-overs are necessary it is usually possible at least to change a furnace to some other alloy in its group, the three principal groups being the straight copper-zinc, the leaded brasses, and the tinned brasses. A change from one group to another, however, does require the furnace to be dumped to prevent off-mixture metal. In this case the early rounds may contain a small amount of an undesirable metal, such as tin or lead, which works out of absorption in the furnace lining.

From the foregoing it is evident that the furnace is best adapted to continuous 24-hour operation with infrequent changes of alloy. It is possible to "hold" the furnace by applying a lowered voltage across the primary of the furnace transformer just sufficient to keep the charge molten,

* Extracted from "The Brass World." The Authors are connected with the Bridgeport Brass Company.

XUM

at a sacrifice of net operating efficiency. It is considerations of the above nature which have kept this type of furnace from being installed in many foundries and some of the brassworks casting shops.

The present range of brasses regularly melted in the induction furnace in the works with which the writers are associated varies from 60 : 40 to 90 : 10, by far the greater percentage of metal lying between 60 : 40 and 70 : 30. Furnaces for melting 2 :1 high brass are usually constructed in 50 to 60 kw. units, although for certain alloys within the high brass range furnaces of 90 kw. are in regular operation. According to information available to the writers, this is about the largest size in which single-phase furnaces are at present being constructed for commercial operation. There is no reason why multiple-phase and possibly single-phase furnaces cannot be constructed in larger units, but the present sizes have proved very convenient for operation in the normal casting shop, and do not impose excessive physical demands on the materials used in their construction.

Continuous Working Methods.

The furnaces usually operate on a 220 volt, 60 cycle, single-phase current supply. If the available supply is 3-phase, the furnaces are distributed on three balanced single-phase systems. Care must be exercised when furnaces are dumped or new ones started, to preserve this phase balance. Running high brass, the furnaces show a power factor of about 80 per cent. The load is very steady, without surges. An uninterrupted power supply is of first importance, and an auxiliary emergency supply, capable of at least holding the furnaces, must be available.

A furnace operating on 2 :1 brass, at a rated input of 50 kw., will melt 12,000 lbs. of high brass per 24-hour day with a power consumption of about 1,175 kw.-h. This usually means from 6 to 8 pours, per 8-hour shift, depending upon the weight poured, in turn dependent upon the size of moulds at that particular furnace.

The operation of these furnaces requires an average of one man per 50 kw. unit. This does not mean that one man takes care of charging, casting, and mould work on one furnace. It has been found by the writers to make for increased efficiency to allow one man to charge and pour two furnaces, leaving mould work to a mould gang. The moulding staff is to some extent "floating," its disposition and apportionment varying with the lineup of the furnaces, at the discretion of the casting foreman. This plan has been found to have the advantage of making casters and mouldmen more efficient at their respective jobs. This efficiency appears as better castings and as a saver of time.

Furnace Limitations.

The present field of reliable operation of the non-ferrous induction furnace is limited to alloys running 90 per cent. copper. Above this field lies a range of useful alloys up to 100 per cent. copper, including the phosphor and other bronzes. While fairly satisfactory runs have been made on practically all of the alloys in this range, the operation of the furnace on these alloys is still erratic and hardly to be considered as on a production basis as yet, especially toward the upper limit of the range.

The limiting factor is almost entirely refractory. The temperature and other characteristics of these high copper alloys impose demands upon the refractory which as yet have not been successfully met. Intensive work is now being carried on along this line, working with a variety of refractory materials and bonds. Encouraging progress is being made, and there is every indication of substantial success in the very near future.

The statement has been made that an ordinary labourer without any previous melting experience can be made a satisfactory electric caster in less than a week's time. This has not been the case in the experience of the writers. It is not to be disputed that the introduction of the electric furnace has removed from the art —and the writers believe it still to be an art—of brass melting, the mystery which, some years ago, almost always shrouded certain phenomena responsible for defects. Scientific research has established certain definite causes for defects which occur periodically, and, further, has pointed out the preventions or remedies necessary to preclude their recurrence.

The radical and complete changes effected in the working conditions of the caster have been assimilated by him so satisfactorily that to-day many of our best casters are the "old timers" not necessarily made over but developed into modern brass casters familiar with and content with our conditions. Frequently, when actual pyrometric readings are not practicable, the caster's experience in co-ordinating kw.-h. input, elapsed time, and metal appearance is the quality that makes the caster, who has had sufficient training, valuable; something that cannot be taught or acquired in less than a week. In the case of automatic mixing within the molten charge, there are times when the caster melting certain alloys must aid this phenomenon by hand stirring. In the opinion of the writers it requires considerably more than a week's time for a green man to familiarise himself with varieties of alloys and moulds, variations of conditions and accurate knowledge of standards necessary to a quality product.

Under the modern system of melting non-ferrous alloys by means of the induction furnace better working conditions exist; working hours are more methodical; and general supervision more complete and scientific, so that as a result the personal efficiency of the caster has been increased materially. Metal loss during the process of melting has so decreased that a much greater net production has followed as a logical sequence. In recovering the brass from casting shop skimmings the absence of residue from burned coal and coke has enabled the installation of less costly recovery machinery with a greater net return. In order that casters may draw dividends from their investment of skill, care and economy in the production of cast metal, incentives are offered dependent upon the net weight and quality of metal produced.

All of the above conditions have been brought about naturally and logically so that to-day a visitor will find casters at this plant working under conditions as favourable, as is consistent with the character of the work, for safety, efficiency and economy of operation. As a natural result, costs of operation have been so reduced from previous practice that the caster, the company and the ultimate consumer of the product have benefited thereby very materially.

Catalogue Received.

Pig-Iron.—The brochure recently issued by Messrs. Bradley & Foster, Limited, of Darlaston, Staffs., strikes a new note in pig-iron publicity. It is made up of 24 art pages and is devoid of the usual illustrations of fractures, but in place contains illustrations of the laboratories, thus emphasising, perhaps unconsciously, modern trend of affairs in this business. The book is particularly dedicated to the practical foundryman. After outlining the history of the works and the composition of the directorate and management, details are first given of the nature of D.M.R. brand of malleable pig-iron. This is followed by similar details appertaining to cylinder pig-iron (R.A.M. and "Special" brands). Some details of cold-blast iron (brand I.X.L.C.B.R.) follow, and in this case the tensile and transverse strengths are given. Descriptions of a Swedish quality of pig-iron containing only 0.06 per cent. sulphur and 0.05 per cent. phosphorus and a low-phosphorus (0.20 to 0.30 per cent.) cylinder iron complete this section.

Of real interest to the practical foundryman is a section devoted to the analyses of cast iron for special purposes. Whilst we do not agree with every single one as being the best for the purpose, the list will be of undoubted benefit to users of pig-iron.

The last section is devoted to tabulating a certain amount of useful information as to the calculation of weights of materials used in the iron foundry.

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CORE GUM,
WHITE DUST,
COAL DUST.

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Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

Trade Talk.

THE CREDENDA CONDUITS COMPANY, LIMITED, have removed to Oldbury, Birmingham.

THE ELECTRO-GENERATOR COMPANY has removed to 5, Uxbridge Road, London, W.12.

CAMMELL, LAIRD & COMPANY'S Penistone Works, Sheffield, have closed down owing to the coal stoppage.

THE ALPINE MONTAN COMPANY, one of the largest ironworks in Austria, is closing down a considerable portion of its plant.

STUART TURNER, LIMITED, Henley-on-Thames, have appointed Clarkson, Hood & Company, 45, Hope Street, Glasgow, as their agents for Scotland and Northern Ireland.

THE YARMOUTH PORT AND HAVEN COMMISSIONERS have accepted the tender of Sir William Arrol & Company, Limited, Glasgow, at £162,062 for the reconstruction of the Haven Bridge.

THE NEW monthly ascertainment price of Cumberland hematite pig-iron, Bessemer mixed numbers, is 76s. 2.74d. per ton, a decrease of 11.94d. per ton, as compared with the previous month's price of 77s.2. 68d.

DURING JUNE only one vessel was launched in the Tyne, as compared with five 12 months before; making 16 launched in the first six months of the current year, as compared with 31 from January 1 to June 30, 1925.

THE POWER GAS ECONOMY COMPANY (T. M. Hunter), 50, Wellington Street, Glasgow, has taken over the British agency for the Bohler vertical continuous furnace for re-heating billets, blooms, slabs, etc., invented by Mr. Bohler, chief engineer of the Jamaille Works of de Wendel & Company.

WITH REFERENCE to the misunderstanding that has recently arisen between certain French railways and French railmakers as regards the price of rails, the Comptoir des Rails has fixed the price at 668 fcs. per metric ton as from July 1 for the third quarter, as compared with the original contract price of 550 fcs. To other customers the price is 800 fcs. per ton delivered.

THE DARLINGTON FORGE COMPANY, LIMITED, last week, removed exceptionally heavy castings by rail from their works to Middlesbrough for shipment. On this occasion it was the transport on seventeen special wagons of four bearings for the new bridge across Sydney Harbour. Each of the four bearings weighs over 300 tons. The main span of the bridge will rest upon them, and measures 1,650 feet.

THE L.N.E.R. COMPANY have placed orders for 200 passenger coaches and all-steel luggage brake vans between the following firms: Cammell, Laird & Company, Limited; Clayton Wagons, Limited; Craven's Railway Carriage and Wagon Company, Limited; Gloucester Railway Carriage and Wagon Company, Limited; Hurst, Nelson & Company, Limited; Metropolitan Carriage, Wagon and Finance Company, Limited; Midland Railway Carriage and Wagon Company, Limited; and R. Y. Pickering and Company, Limited. Two steam rail coaches have been ordered from the Sentinel Wagon Works, Limited.

MISS C. HASLETT, the secretary of the Women's Engineering Society, announces that the fourth annual conference of women engineers will be held at the Leeds University from September 3 to 6. On the opening day Mrs. L. A. Willson, president of the Women's Engineering Society, will deliver her presidential address. On Saturday, September 4, there will be a visit to the locomotive works of Kitson & Company, Limited, Airedale Foundry, followed by the following papers: Miss C. Griff, "Stainless Steel and its Place in Engineering"; Mrs. M. L. Matthews, "Portable Electric Tools with Some Newer Developments." Subsequently the annual meeting will be held. On September 5, the members will leave for Halifax, where a visit will be paid to Mrs. Willson's housing schemes, also to the lathe works of Smith, Barker & Wilson.

INCLUDED AMONG the many things which were put to the test during the recent general strike was electrical equipment of every description, as in numerous instances it was impossible to give even the most perfunctory supervision. A notable case is afforded by the following particulars concerning the behaviour of an automatic substation, containing two British Thomson-Houston rotary converters, each of 1,200-kw. capacity, and B.T.H. automatic control equipments. This automatic substation is one of many engaged in supplying current to the track for electric railway service, and its behaviour is typical of all. The users' report is that "Within three minutes of receipt of instructions to start up the service, the substation was put on to load, and it operated right through the strike without any attention whatever, either in the way of oiling, inspection, adjustment, or anything else. A superintendent looked into the substation for a few minutes at the end of the first week, but beyond that no visits were paid to the substation."

Company Reports.

National Smelting Company, Limited.—Dividend on ordinary, 5 per cent., free of tax.

Monks, Hall & Company, Limited.—Profit, £14,151; brought forward, £83,153; available, £97,304; final dividend, 2½ per cent., making 5 per cent., tax free, for year; carried forward, £48,100.

David and William Henderson & Company, Limited.—Balance at credit of profit and loss, £45,840; preference share dividend for half-year, £7,500; depreciation, £6,260; carried forward, £32,080.

Thomas Bolton & Sons, Limited.—Final dividend, 2½ per cent., making 5 per cent. for year; £10,000 to reserve against land valuation; £5,000 to reserve against debts and investments; £7,248 forward.

Furness, Withy & Company, Limited.—Profits, £523,044; brought forward, £187,259; bonus, 2½ per cent., free of tax, on ordinary shares, making for year 7½ per cent., free of tax; depreciation, £200,000; carried forward, £150,303.

Agricultural and General Engineers, Limited.—After expending £70,858 on maintenance of plant, tools, etc., ten firms made profits amounting to £188,632, and two firms made losses totalling £15,393, leaving surplus £173,239; depreciation on plant, etc., £54,831; depreciation of stocks, £10,136; depreciation of reserve, £10,209; taxation, £7,885; dividends paid to outside shareholders, £7,500; interest on debentures, etc., £6,577. After crediting £93,697 dividends and contributions from associated companies, £11,154 surplus on Aldwych House revenue account, and deducting bank and other interest, etc., credit revenue balance, £52,471; in view of present unsettled trade and industrial conditions, decided to carry forward this sum.

New Companies.

C. Mortlock, Limited.—Capital £1,000 in £1 shares. Electrical engineers. Directors: C. T. Mortlock, 30, Station Road, Penge, S.E.; Mrs. E. A. Mortlock, 30, Station Road, Penge, S.E.

E. T. White & Company (1926), Limited.—Capital £8,000 in 1,500 10 per cent. non-cumulative preference and 6,500 20 per cent. ordinary shares of £1. Engineers. Directors: E. T. White; J. C. McClure; E. J. Burrows, 29, Lyndhurst Road, Highams Park, E.4; and T. G. Greenleaf, 36, Sistova Road, Balham, S.W.12.

Fletcher, Taylor & Company, Limited, Station Works, Murton, near York.—Capital £3,000. Steel, structural and general engineers, etc. Permanent directors: S. H. Fletcher, Rivelin House, Hoggard Hill, Huntingdon, Yorks.; A. Hardgrace, 55, Monkgate, York; G. E. Barker, 13, Bishophill, York.

Fullers (Ilford), Limited.—Capital £52,500 in 45,000 10 per cent. preferred ordinary shares of £1 and 150,000 deferred shares of 1s. Engineers. Directors: C. H. Wayte, Manor Cottage, Stoke d'Abernon, Surrey; L. Fuller, "Sunnycroft," Old Road, Frinton-on-Sea; and G. J. A. Fuller, "Brooklyn," Loughton, Essex.

John Chaloner & Company, Limited.—Capital £5,000 in £1 shares (4,000 5 per cent. cumulative preference and 1,000 ordinary). Engineers. Directors: G. M. Haworth, Chapel-en-le-Frith; W. Chaloner, 12, St. Peter Street, Stockport; and J. Chaloner.

Rubery Owen Foundries, Limited, Bilston Lane, Willenhall, Staffs.—Capital £25,000 in £1 shares. Directors: A. E. Owen, D. C. Lloyd and L. O. Smith.

Gazette.

THE WOLF ENGINE COMPANY, LIMITED, are being wound up voluntarily. Mr. O. Schweitzer Bush House, Aldwych, London, W.C.2, has been appointed liquidator.

A RECEIVING ORDER has been made by Mr. A. Wilkinson, 9, Stockport Road, Romiley, lately carrying on business at Denton Road, Audenshaw, under the style of Marshall & Wilkinson, ironfounders.

THE PARTNERSHIP heretofore subsisting between Messrs. J. Cartwright and H. Parkin, jun., machine file cutters and file manufacturers, Snow Lane, Sheffield, under the style of Parkin & Cartwright, has been dissolved. The business will be carried on by Mr. J. Cartwright.

THE PARTNERSHIP heretofore subsisting between Messrs. H. Speight and A. D. Campbell, ironfounders, Dockfield, Shipley, under the style of the Dockfield Foundry Company, has been dissolved. The business will be carried on in the future by Mr. H. Speight under the same style.

"SERVICE GRC FIRST"

WE ARE STILL CARRYING ON

in all departments, and can execute orders for any class or kind of refractory material.

We are independent of outside coal supply, and will welcome enquiries of all kinds. We have even a little coke and slack to sell.

GENERAL REFRACTORIES Co., Ltd., SHEFFIELD.

BCM/OK9
LONDON.

No need to try and remember our name in case it is unfamiliar to you. This is our British Monomark. Envelopes addressed simply thus will be delivered to us by arrangement with the G.P.O.

THE FOUNDRY TRADES EQUIPMENT & SUPPLIES ASSOCIATION LTD.

IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—The steady and continuous drain upon Cleveland iron resources during the strike period has about reached the culminating point, and at the present time there are very limited stocks, strictly reserved for the urgent needs of old and favoured customers only, with but faint prospects of any early resumption of furnace outputs. In the circumstances thus briefly outlined, there is, of course, no semblance of market conditions, and business in the normal course cannot be restored until the crisis has passed. After that, it will be several weeks before the furnaces can be got fully away again. With regard to prices, these now stand as follow:—No. 1, 92s. 6d.; No. 3 G.M.B., 90s.; No. 4 foundry, 89s.; and No. 4 forge, 88s. 6d. per ton. Export prices are nominally 6d. per ton more.

The scarcity of foundry iron has not had the stimulating effect that was expected upon the demand for hematite, the position of which all round is practically unchanged. It is understood, however, that the two furnaces on Tees-side still in operation on hematite are to be switched over to a low-phosphorus foundry iron. Should this be the case, hematite will be correspondingly stiffened, while supplies of foundry iron will be to a similar extent easier. Mixed numbers are now quoted at 81s., with 6d. per ton more for the No. 1 quality. On the North-West Coast prices are unchanged, with Bessemer mixed numbers £4 4s. c.i.f. Welsh ports, £4 7s. 6d. per ton delivered at Glasgow, £4 9s. 6d. to £4 11s. 6d. per ton delivered at Sheffield, and £4 17s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—As stated in recent reports of local markets, there are no free offers whatever of Staffordshire, Derbyshire and Lincolnshire brands of foundry iron. After a brief absence from the market, Scottish iron has been again on offer at Manchester, but in very small quantities, and at a high figure, sellers asking up to 102s. 6d. per ton for No. 3 iron, at which price an odd parcel or two of Middlesbrough iron was also offered. For what work they are in a position to tackle, having regard to the fact that most of them are in a serious position from the point of view of fuel, many of the foundries have probably sufficient iron in stock.

THE MIDLANDS.—Markets in this area continue in a stagnant condition, the only qualities of foundry iron now obtainable being No. 1 and No. 3 Cleveland, with a little Shropshire "all mine" and hematites. There has been a much better call of late for the latter, and prices have improved accordingly. Middlesbrough No. 1 is offered at about 106s. per ton, delivered stations or sidings, and there is a little No. 3 of this grade on offer for August delivery, at about 102s. 6d. to 103s. 6d. Scotch No. 3, of which limited quantities are offered for early despatch, is quoted at 105s.

SCOTLAND.—During the holiday period, extending over the next week or two, business in the Scottish markets for foundry iron is virtually suspended, but prices are firm all round. Some makers are still quoting 82s. 6d. for No. 3 at the furnaces, but others are asking much more. With a further advance in Middlesbrough, Scotch iron is still moderately priced, and buyers are naturally buying local iron where they can. Continental foundry iron is obtainable at 74s., as compared with over 90s. for Middlesbrough, so that there is every inducement to buy the former.

Steel.

Production in all departments of the steel industry has now been reduced to almost negligible proportions, especially in the Welsh area, while practically the only material available is imported, and deliveries for these are becoming extended. There has also been a fair tonnage of steel sections, joists and plate business placed with Continental works within the last week or two for delivery in August. Joists from this source are a little firmer at £4 15s. and £4 16s., f.o.b. Antwerp, or about £5 17s. 6d. per ton delivered works here for British standard sections and 28/32 tons tensile. Angles and plates are quoted at £6 and £6 2s. 6d. per ton delivered respectively. Quiet conditions continue in the tinplate trade, but a few more mills are operating. Prices for stock plates remain firm, and business has been done at round 26s. basis T.C., f.o.b. works' port, whilst forward plates at the close of the stoppage have been bought at 20s. 6d.

Finished Iron.

No fresh developments in this section of industry can be reported, or, indeed, expected, at the moment, and trade generally remains quiet and uneventful. Inquiries for bar material continue in limited volume, the bulk of the business done being with Continental makers. Some good orders for nut and bolt bars have been placed just recently with Belgian houses, and the current quotations for this class of iron are round about £5 17s. 6d. per ton, delivered works in the Black Country area. Prices, however, rule firm for the home products, current quotations ruling at £11 5s. and up for crown bars, with marked brands at £14 per ton, f.o.t. makers' works.

Metals.

Copper.—Business in this section of the market of late has developed on a more active scale, with standard values evidencing a consistent upward tendency, strengthened, doubtless, by a definite announcement that the Copper Export Trading Association will commence operations most probably at the end of August. It is argued that such a display of confidence while current European trade drawbacks still exist, points to the possibility of unusual conditions prevailing in the autumn, when the above-mentioned Association commences to make its influence felt, and the Continental demand may develop in a more normal business atmosphere.

Official closing prices of standard copper have been as follows:—

Cash: Thursday, £58 5s. to £58 7s. 6d.; Friday, £58 5s. to £58 7s. 6d.; Monday, £58 7s. 6d. to £58 10s.; Tuesday, £58 7s. 6d. to £58 10s.; Wednesday, £58 10s. to £58 12s. 6d.

Three Months: Thursday, £59 to £59 2s. 6d.; Friday, £59 to £59 2s. 6d.; Monday, £59 2s. 6d. to £59 5s.; Tuesday, £59 5s. to £59 7s. 6d.; Wednesday, £59 5s. to £59 7s. 6d.

Tin.—Stimulated by optimistic views of the end-of-month statistical returns, standard tin values continue buoyant, making a further substantial advance on the previous week's closing quotations. The outlook in tin has been eagerly discussed of late, having regard to the fact that the world's consumption is being maintained at a rate quite sufficient to take care of the current output, while American requirements this year promise to be on a heavy scale. Continental consumption is quite good, and it can only be assumed that, with a cessation of the coal crisis, the home outlet will speedily expand.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £286 15s. to £287; Friday, £287 10s. to £287 12s. 6d.; Monday, £289 to £289 5s.; Tuesday, £289 7s. 6d. to £289 10s.; Wednesday, £289 17s. 6d. to £290.

Three Months: Thursday, £283 to £283 5s.; Friday, £283 to £283 2s. 6d.; Monday, £284 to £284 5s.; Tuesday, £284 5s. to £284 7s. 6d.; Wednesday, £284 15s. to £284 17s. 6d.

Spelter.—Movements in the spelter market of late point to anticipations of an early recovery in trade, developing in an active demand on home consumers' account in the near future. The metal has, in fact, followed lead under bull buying and restricted Continental offers, while dock labour troubles in Antwerp affected the position, although these difficulties have now subsided.

The following are the week's prices:—

Ordinary: Thursday, £34; Friday, £34 2s. 6d.; Monday, £34 5s.; Tuesday, £34 8s. 9d.; Wednesday, £34 8s. 9d.

Lead.—Inquiries for soft foreign pig from consumers has expanded, and with renewed buying by Germany and Russia, the market has been strong. The consumption in the United Kingdom during 1925 was on a record scale, and it would seem that, in spite of serious industrial disturbances, consumption during the first half of this year has been practically as heavy in comparison with the same period in 1925.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £32 2s. 6d.; Friday, £32 3s. 9d.; Monday, £32 15s.; Tuesday, £33 5s.; Wednesday, £32 17s. 6d.

THE SEVENTY-EIGHTH Anniversary Festival of the Royal Metal Trades' Pension and Benevolent Society, postponed from June 1, has been fixed for Tuesday, November 2, at the Guildhall, London. H.R.H. the Prince of Wales has consented to be present. The chairman will be the Right Hon. Sir William Robert Pryke, Lord Mayor of London.

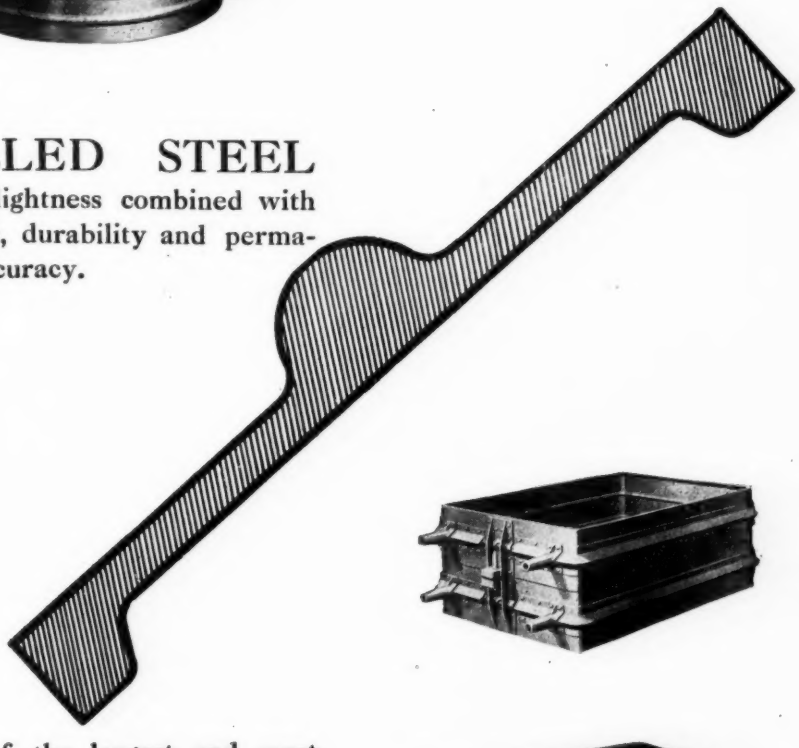
Sterling

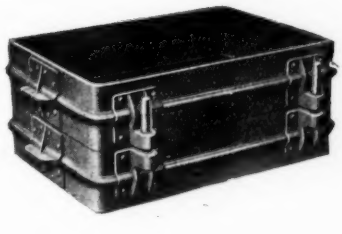
Lightness and ease of handling, robust construction, accuracy and durability are the paramount essentials of the modern Moulding Box.

These qualities are solidly built into all STERLING ROLLED STEEL BOXES.

ROLLED STEEL

means lightness combined with strength, durability and permanent accuracy.





Some of the largest and most up-to-date Foundries in the country are now completely equipped with STERLING BOXES. If you are not already a Sterling user investigate the matter without delay.

STERLING FOUNDRY SPECIALTIES LTD.
BEDFORD

London Office: 13, VICTORIA STREET, S.W.1.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	58	10	0
Three months ..	59	5	0
Electrolytic	66	5	0
Tough	64	0	0
Best selected ..	64	10	0
Sheets	90	0	0
India	74	0	0
Wire bars	66	12	6
Do. August ..	66	12	6
Do. Sept.	66	12	6
Ingot bars	66	5	0
H.C. wire rods ..	70	10	0
Off. av. cash, June	56	16	9 2/11
Do., 3 mths. June	57	14	1 1/11
Do.,Sttlmnt, June	56	17	1 10/11
Do., Electro, June	64	16	7 1/11
Do., B.S., June ..	62	4	2
Aver. spot price copper, June ..	56	17	2
Do.,wire bars, June	65	11	4½
Solid drawn tubes		12¾d.	
Brazed tubes ..		12¾d.	
Wire		9½d.	

BRASS.

Solid drawn tubes ..	11¾d.
Brazed tubes	13½d.
Rods, drawn	10¾d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g ..	10½d.
Wire	9¾d.
Rolled metal	9½d.
Yellow metal rods ..	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

	£	s.	d.
Standard cash ..	289	17	6
Three months ..	284	15	0
English	290	10	0
Bars	292	10	0
Straits	300	7	6
Australian		—	
Eastern	292	10	0
Banca		—	
Off.avr. cash,June	268	9	5 10/22
Do.,3 mths.,June	267	13	0 3/22
Do.,Sttlmt. June	268	8	7 7/11
Aver. spot., June	268	9	6

SPELTER.

	£	s.	d.
Ordinary	34	8	9
Remelted	33	5	0
Hard	29	0	0
Electro 99.9 ..	37	10	0
English	34	17	6
India	31	5	0
Zinc dust	42	0	0
Zinc ashes	15	0	0
Off. aver., June	33	6	5 1/22
Aver., spot, June	33	4	10 4/22

LEAD.

	£	s.	d.
Soft foreign ppt.	32	17	6
English	34	5	0
Off. average, June	30	1	3 15/22
Average spot, June	29	19	8½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	42	0	0
Do. V.M. ex whf.	39	10	0
Rods	44	0	0
Boiler plates ..	38	10	0
Battery plates ..	38	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	74	10	0
Chinese	62	0	0
Crude	40	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver ..	15	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon 25%	9	0	0
45/50%	11	0	0
75%..	18	5	0
Ferro-vanadium— 35/40% ..	15/- lb. va.		
Ferro-molybdenum— 70/75% c. free ..	5/9 lb.		
Ferro-titanium— 23/25 carbonless	11½d. lb.		
Ferro-phosphorus, 20/25%,	£17	0	0
Ferro-tungsten— 80/85%,c.fr. ..	1/4½ lb.		
Tungsten metal powder— 98/99% ..	1/10½ lb.		
Ferro-chrome— 2/4% car. ..	£33	10	0
4/6% car. ..	£22	0	0
6/8% car. ..	£21	10	0
8/10% car. ..	£20	15	0
Ferro-chrome— Max. 2% car.	£37	0	0
Max. 1% car.	£43	10	0
Max.0.70%car.	£54	10	0
70%,carbonless	1/5½ lb.		
Nickel—99%, cubes or pellets ..	£170		
Cobalt metal—98/99%	10/- lb.		
Aluminium 98/99%	£118		
Metallic Chromium— 96/98%	3/3 lb.		
Ferro-manganese (net)— 76/80%, loose	£15	0	0
76/80%, packed	£16	0	0
76/80%, export	£14	5	0
Metallic manganese— 94/96%, carbonless	2/- lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten ..	2	6
Finished bars, 18% tungsten ..	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. and over .. 4d.lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Do. under ¼in. to ⅛ in. .. .. 1/- lb.
Flats, ½in. × ⅛in. to under 1 in. × ⅛ in. 3d. lb.
Do. under ½in. × ⅛in. 1/- lb
Bevels of approved sizes and sections 6d. lb.
Bars cut to length 10%extra
Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	5	0 to	3	7	6
Bundled steel & shrngs.	3	3	0 to	3	6	0
Mixed iron & steel	3	0	0			
Heavy cast iron	3	0	0			
Good machinery for foundries ..	3	5	0			
Cleveland—						
Heavy steel ..	3	1	0			
Steel turnings ..	2	6	0			
Cast iron borings	2	5	0			
Heavy forge ..	4	2	6			
Bushelled scrap	3	10	0			
Cast-iron scrap	3	8	6			
Lancashire—						
Cast-iron scrap	3	2	6 to	3	10	0
Hvy. wrought ..	3	2	6			
Steel turnings ..	2	2	0			

London — Merchants' buying prices delivered yard.

Copper (clean)..	48	0	0
Brass (clean) ..	39	0	0
Lead (less usual draft)	27	10	0
Tea lead ..	23	10	0
Zinc	22	0	0
New aluminium cuttings ..	80	0	0
Braziery copper	44	0	0
Gunmetal ..	45	0	0
Hollow pewter	185	0	0
Shaped black pewter ..	135	0	0

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1 ..	92/6
Foundry No. 3 ..	90/-
Foundry No. 4 ..	89/-
Forge No. 4	88/6
Hematite No. 1 ..	81/6
Hematite M/Nos. ..	81/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	87/6
„ d/d Birm.	97/6
Midlands—	
Staffs common* ..	—
„ No. 4 forge ..	—
„ No. 3 foundry	—
Shrops. basic	—
„ Cold blast, ord.*	—
„ „ roll iron* ..	—
* d/d Birmingham.	
Northants forge	—
„ fdry No. 3 ..	—
Derbyshire forge ..	—
„ fdry. No. 3 ..	—
„ basic	—
Scotland—	
Foundry No. 1 ..	—
„ No. 3 ..	85/-
Hem. M/Nos.	79/-
Sheffield (d/d district)—	
Derby forge	—
„ fdry. No. 3 ..	—
Lincs. forge	—
„ fdry. No. 3 ..	—
E.C. hematite	92/6
W.C. hematite ..	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3.. ..	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3 ..	—
Northants foundry No. 3	—
Dalzell, No. 3	110/-
Summerlee, No. 3 ..	102/6
Glengarnock, No. 3 ..	102/6
Gartsherrie, No. 3 ..	102/6
Monkland No. 3	102/6
Coltness, No. 3	102/6
Shotts, No. 3	102/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars(cr.)	11	5	0 to	12	0	0
Angles				11	10	0
Tees to 3 united ins.				12	0	0
Nut and bolt	10	5	0 to	10	7	6
Hoops	14	0	0 to	15	0	0
Marked bars (Staffs.) f.o.t. ..				14	0	0
Gas strip				12	10	0
Bolts and nuts ¾ in. × 4 in. ..				15	5	0
Steel—						
Ship plates				8	2	6
Boiler plts. ..				11	5	0
Chequer plts. ..				10	0	0
Angles				7	7	6
Tees				8	7	6
Joists				7	7	6
Rounds and Squares 3 in. to 5½ ins. ..				8	0	0
Rounds under 3 in. to ¾ in.				7	15	0
Flats, over 5 in. wide and up ..				8	10	0
Flats, 5in. to 1½in.				7	10	0
Rails, heavy ..				8	0	0
Fishplates				12	0	0
Hoops (Staffs.) ..				10	10	0
Black sheets, 24g.				11	2	6
Galv. cor. sheets, 24g.				17	0	0
Galv. fencing wire 8g. plain				13	0	0
Billets, soft ..				6	10	0
Billets, hard ..				8	2	6
Sheet bars				6	5	0
Tin bars d/d ..				6	5	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3½
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/- to 1/8½
Wire round— 3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	19.76
No. 2 foundry, Birm.	21.00
Basic	19.76
Bessemer	20.76
Malleable	19.51
Grey forge	19.01
Ferro-mang. 80% d/d	88.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	2.00
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 28..	3.10
Sheets, galv., No. 28 ..	4.25
Sheets, blue an'l'd, 9 & 10	2.30
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
„ furnace	—
Durham & North.	
„ foundry	—
„ furnace	—
Other Districts, foundry	—
„ „ furnace (basis)	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	26/-
„	28×20, „	52/-
„	20×10, „	—
„	18¾×14, „	—
C.W.	20×14, „	24/-
„	28×20, „	—
„	20×10, „	—
„	18¾×14, „	—

Terneplates 28×20, — per box basis f.o.b.

SWEDISH IRON.

Bars,hammered	£18/10 to £19/0
Rolled Ord.	£15/10/0 to £16
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 5 0 to £7 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes	*Fittings*
Gas ..	60%	.. 50%
Water ..	55%	.. 45%
Steam ..	50%	.. 40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
July 22	58	5	0	inc. 10/0
,, 23	58	5	0	No change
,, 26	58	7	6	inc. 2/6
,, 27	58	7	6	No change
,, 28	58	10	0	inc. 2/6

Electrolytic Copper.

	£	s.	d.	
July 22	66	0	0	inc. 10/-
,, 23	66	0	0	No change
,, 26	66	5	0	inc. 5/-
,, 27	66	5	0	No change
,, 28	66	5	0	,, ,,

Standard Tin (Cash).

	£	s.	d.	
July 22	286	15	0	inc. 32/6
,, 23	287	10	0	,, 15/-
,, 26	289	0	0	,, 30/-
,, 27	289	0	0	No change
,, 28	289	17	6	inc. 17/6

Tin (English ingots).

	£	s.	d.	
July 22	285	10	0	inc 30/-
,, 23	286	10	0	,, 20/-
,, 26	288	0	0	,, 30/-
,, 27	288	7	6	,, 7/6
,, 28	290	10	0	inc. 42/6

Zinc Sheets (English).

	£	s.	d.	
July 22	42	0	0	No change
,, 23	42	0	0	,, ,,
,, 26	42	0	0	,, ,,
,, 27	42	0	0	,, ,,
,, 28	42	0	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
July 22	34	0	0	inc. 1/3
,, 23	34	2	6	,, 2/6
,, 26	34	5	0	,, 2/6
,, 27	34	8	9	inc. 3/9
,, 28	34	8	9	No change

Lead (English).

	£	s.	d.	
July 22	33	10	0	dec. 5/-
,, 23	33	10	0	No change
,, 26	34	0	0	inc. 10/-
,, 27	34	10	0	,, 10/-
,, 28	34	5	0	dec. 5/-

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	4 15 0	4 17 6	5 0 0	5 0 0	5 0 0	4 17 6	4 17 6	4 17 6	4 17 6	5 0 0	5 7 6	5 7 6	4 19 9½
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 5 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	7 5 0	7 12 6	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 -5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	—	—	—	—	—	7 2 10½

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